MACHINERY

DECEMBER, 1914

MAKING VERTICAL FORMING TOOLS*

PRACTICE OF THE WINDSOR MACHINE CO. IN PRODUCING VERTICAL FORMING TOOLS FOR THE GRIDLEY AUTOMATIC

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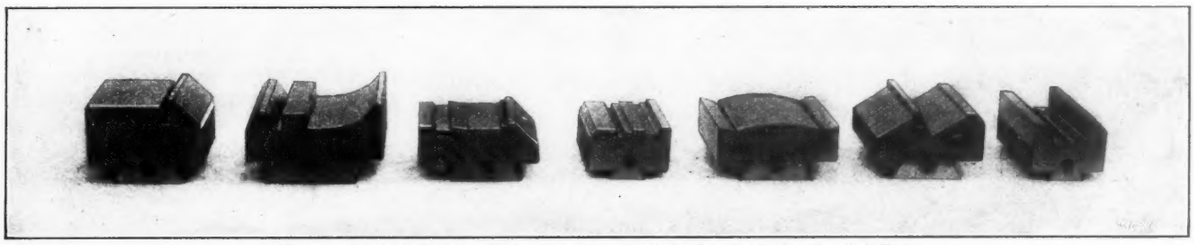

Fig. 1. Vertical Forming Tools that were finished after hardening by Grinding

THE automatic machine tool, in its present state, has materially increased the productiveness of the machine shop and raised the standard of efficiency. Machine parts are now produced by the score in modern automatic turning machines in the same time that a single piece was formerly made on an engine lathe. While we naturally consider the automatic machine as a whole, its remarkable efficiency depends largely upon the tool equipment, and as the manufacture of forming tools presents some rather difficult practical problems, information on making these tools is given in this article. The methods referred to represent the practice at the Windsor Machine Co., Windsor, Vt., in the production of the vertical forming tools such as are used on the Gridley automatic machines.

Forming tools of all kinds were made at first by being shaped to the form required, it being necessary for the mechanic to use his best judgment in allowing for changes in hardening; therefore, this method was, to a certain extent, a matter of guesswork, and as tools of different shapes would not be affected alike by the changes connected with hardening, it was impossible to be sure of accurate results. To overcome this defect, the Windsor Machine Co., a few years ago, began the practice of grinding its vertical style of forming tools after the hardening operation. By this method, the accuracy of the form is limited only by the skill of the mechanic and quality of the tools used in doing the work. This grinding of the hardened forming tools has practically solved the problem of accuracy and has made it possible to turn parts of much more intricate shape, and secure true corners, curves, and angles on the work.

Figs. 1 and 2 illustrate a few of the many shapes of vertical forming tools that have been ground. These tools, with their corners, curves and angles, indicate, in a general way, to what extent the range of the automatic turning machine has been increased, due to the development of the forming tool. Fig. 3 shows a double forming tool-holder on a Gridley automatic, the lower tool roughing out the form, leaving only a small amount of stock to be removed by the upper or finishing tool. This plan results in a great saving of the tools because the finisher does the light work and will hold its edge

* For additional information on this subject, see the following articles previously published in MACHINERY: "Straight and Circular Forming Tools," June, 1904; "Charts for Forming Tools," October, 1904; "Forming Tools," December, 1904; "Forming Tools for Gear Cutters," July, 1914.

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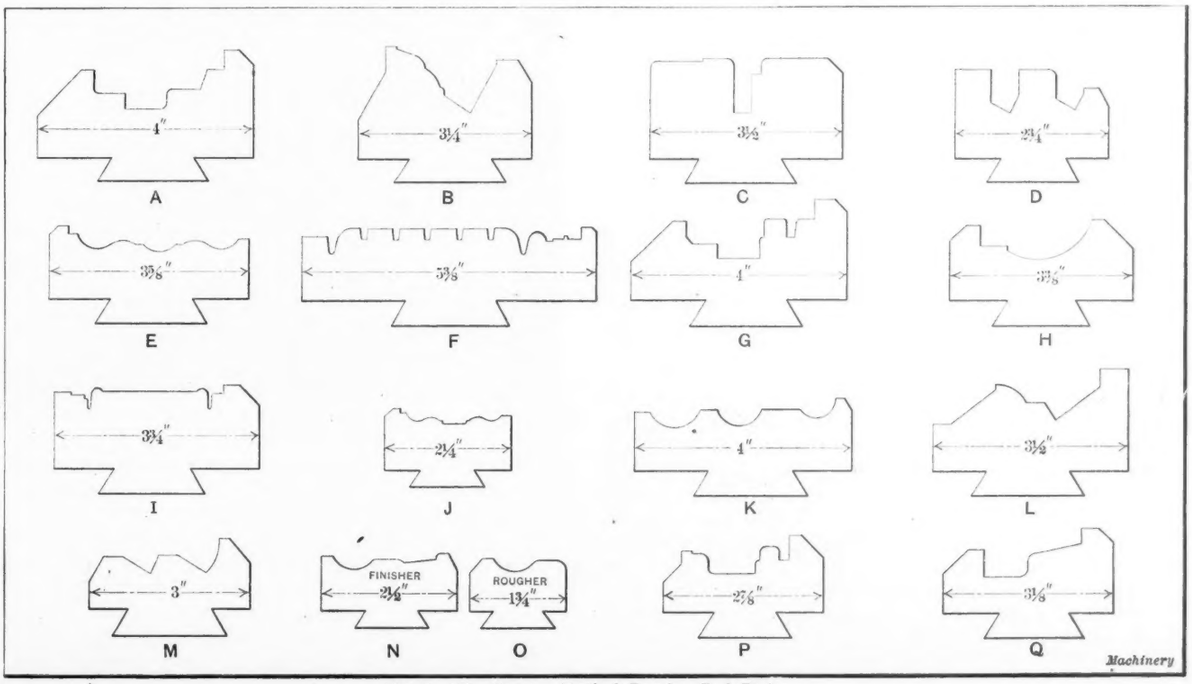

Fig. 2. Miscellaneous Vertical Forming Tool Designs

much longer; moreover, the roughing tool can be made more quickly, as its form is not required to be so accurate and the shape can often be simpler than is required on the finishing tool. An example, illustrating the difference between a roughing and finishing tool, is shown at *N* and *O*, in Fig. 2. As will be seen, the roughing tool is much narrower than the one for finishing, because it only operates where considerable stock must be removed. Fig. 4 shows another vertical forming tool in position on a Gridley automatic. These heavy, wide tools are able to withstand severe duty on account of the rigid way they are held, and, moreover, the tool may be removed easily for grinding or sharpening.

One of the most frequent questions arising in regard to

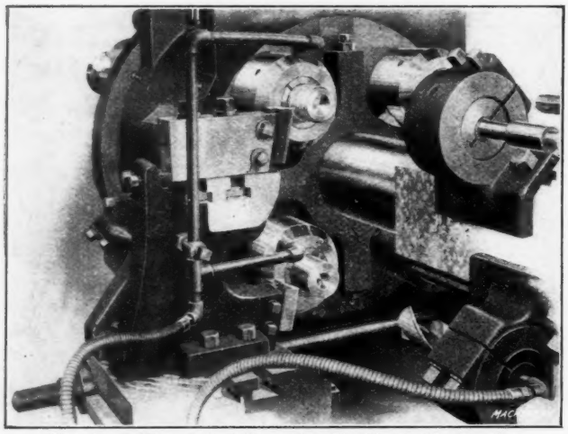

Fig. 3. Gridley Automatic equipped with Double Forming Tool-holder and Tools for Roughing and Finishing

grinding forming tools is the expense, many believing that it takes more time than is actually required and that it is not advisable to grind the tools owing to the cost. Within reasonable limits, the time should not be considered, because when a vertical tool is completed it will produce hundreds of parts, to say nothing of the accuracy of production and duplicating qualities of the work. At first thought, one might charge all the time consumed in grinding plus the time it would take to finish a tool in the old way, but this is incorrect as much time is saved on the shaper work because it is not necessary to plane the form so accurately when the tool is to be ground afterward, and coarser feeds may be employed. Because of this advantage, very little extra time is required for grinding, and this additional time is certainly offset by the accurate surfaces and measurements obtained on the work.

Before grinding a forming tool, it is first roughed out on a shaper, as indicated in Fig. 5, 0.010 or 0.015 inch being left for grinding. The back of the tool or dovetail is finished to size so that no unnecessary grinding is required. The grinding is all done on a surface grinder fitted with a magnetic plate or chuck. The fixture for holding the tools while being ground is a very simple device and is illustrated in Fig. 6. It is essential that the top and bottom of the fixture be perfectly parallel and also that the fixed edge of the dovetail be true with both edges or sides of the base. If the straightedge on the magnetic chuck is true, obviously this holder can be removed and replaced without affecting the accuracy of the work; it can also be changed end for end when grinding, although care should be taken that the holder and magnetic chuck are clean when such changes are made. By inserting a thin piece of steel of the required thickness between the straightedge and fixture, the necessary clearance for the vertical faces of the tool can also be obtained, as will be described more fully later. In order to illustrate the general method of procedure in producing various vertical forming tools, the different operations on the particular tool shown at *G*, Fig. 2, will be described in detail, as this tool is typical in many respects.

Dimensioning and Laying Out a Forming Tool

When making the drawing of a forming tool, the draftsman should make each horizontal measurement correspond exactly with each relative measurement of length on the article to be turned. The vertical measurements should, preferably, be given at right angles to the front face of the tool, so that the mechanic can work directly from the drawing; in this way, the liability of mistakes is lessened and the work can be done more rapidly. Of course, these dimensions at right angles to the face of the tool vary slightly from the actual dimensions on the work, owing to the clearance angle, and must be calculated, as explained under the heading "Vertical Forming Tool Calculations."

The exact method of procedure when laying out a tool depends, of course, largely upon the form of the cutting edge. Fig. 7 indicates, in a general way, however, how this work is done. The tool shown by the diagrams *A* to *F*, inclusive, is similar to the one illustrated at *G* in Fig. 2. After copper-plating the front end or working face of the tool (by using a copper-sulphate solution) place the block on a surface plate with side *x* down; then with a scratch block resting upon a combination of size blocks equal in height to dimension *a* (see sketch *B*) plus 0.010 inch, scribe the first of the vertical lines (sketch *J* indicates how the scratch block is used in conjunction with the size blocks). By using different combinations of size blocks, scribe each succeeding vertical line until all the lines are laid out as indicated at *B*. The first measurement *a* is the only one that is made 0.010 inch greater than the dimension on the drawing, this allowance being left for grinding the left side; the distances between the other lines must be precise.

Next place the block on surface *y* (see sketch *A*), and scribe, in the same manner, all horizontal lines, as indicated at *C*; then with a protractor set at the required angle, draw lines *c–d* and *e–f*, and also the two corner angles as at *D*. With dividers, scribe arcs of the correct radius in each corner that is to be rounded. The block is now ready to be roughed out on the shaper.

It is needless to dwell on the method of removing the stock in the shaper, but when performing this operation, allowances for grinding should be made (as indicated by the dotted lines on sketch *E*, Fig. 7), 0.007 or 0.008 inch being left on a side; that is, measurements between faces such as *g* or *h* (sketch *F*) should be left about 0.015 inch narrow, while a measurement like *k* should be about 0.015 inch wide. No allowance need be made on vertical measurements because the same amount can be ground from each surface, so that there will be no change in the measurements. When roughing the tool out in the shaper, it is preferable to plane the surfaces straight or parallel, making no allowance for clearance on the side faces. The amount to be removed for clearance is so slight that it can easily be ground. When the tool

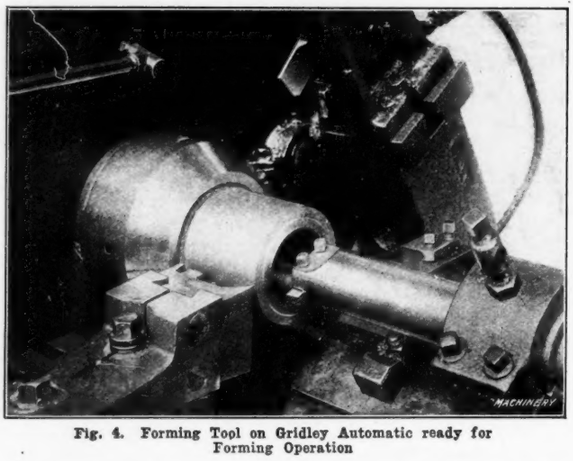

Fig. 4. Forming Tool on Gridley Automatic ready for Forming Operation

has been roughed out, the upper end or working face should be beveled off to the required clearance angle which, at the Windsor Machine Co., is made 12 degrees.

Set of Wheels for Grinding Forming Tools

When grinding forming tools, the general rule for the selection of wheels, *viz.*, use soft wheels for hard metal and *vice versa*, cannot always be strictly adhered to. Numerous experiments made by the writer have shown that the best results in grinding are obtained by using a wheel made of alundum, different grades and grains being used according to

requirements. The following list gives an ample variety and all the shapes that are required may be obtained by using one wheel or the other and dressing the wheel face off to suit the shape desired on the tool.

GRINDING WHEELS FOR FORM TOOL GRINDING

Style	Diameter	Width	Grain	Grade
Straight...	7	$\frac{1}{2}$	46	H
Straight...	6	$\frac{1}{2}$	46	K
Straight...	6	1	46	H
Straight...	6	$\frac{1}{4}$	46	K
Straight...	6	$\frac{1}{2}$	46	M
Cup.....	6	1	46	I
Cup.....	4	$1\frac{3}{8}$	46	K
Cup.....	4	$1\frac{3}{8}$	60	K
Saucer.....	6	$\frac{5}{16}$	46	K
Saucer.....	6	$\frac{5}{16}$	60	K

Machinery

Quite a number of wheels is necessary to secure economical results, but when a stock of wheels is secured, the consumption is small if they are handled properly. When first starting to grind form tools, one should not make too radical a change in the shape of a wheel face, but secure another size which is more suitable. In this way, there will soon be a variety large enough so that a wheel can be found which will require but little dressing to reproduce almost any form desired. Some wheels which have been formed from those given in the foregoing list, are illustrated in Fig. 8.

Method of Grinding a Typical Forming Tool

After the tool is hardened, it is ground to the finished dimensions. The first operation is to grind the upper end or working face of the tool. Enough should be ground off to insure sharp corners or edges, without having to grind too much on the formed surfaces. For this operation, the tool may be held in an ordinary vise. The next operation is that of grinding the formed part of the tool. The dovetailed clamping surfaces should first be inspected to see if they are clean. The tool is then clamped in a fixture similar to

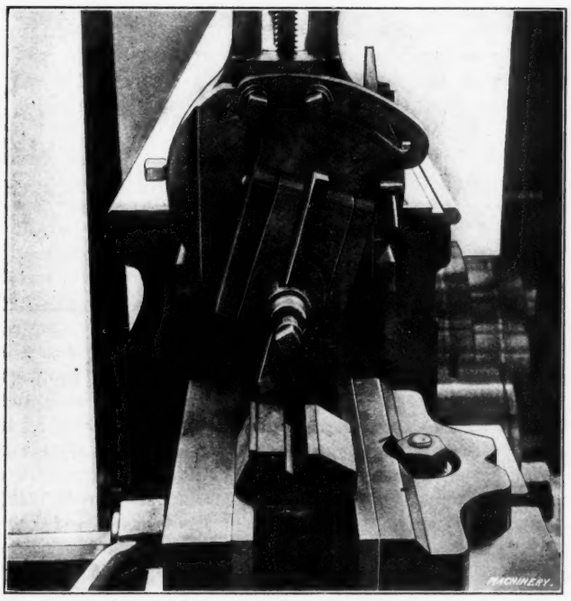

Fig. 5. Roughing Out Forming Tool on Shaper preparatory to Grinding

that shown on the surface grinder in Fig. 6. The tool shown in this illustration, however, does not correspond in form with the one selected as an example and illustrated in Fig. 7.

Naturally, the first surface that should be ground is the one that is highest, thus providing a resting place for the base of the depth gage. All vertical measurements (as held for grinding) should be given from this surface. For measuring vertically when grinding, the writer always uses a micrometer depth gage, while for horizontal measurements, a set of size blocks is employed. These blocks range from 0.031 to 0.063 inch, by one-thousandth inch increments, and then by one-sixteenth inch increments up to one inch. This set gives all measurements required for this work.

If there is a dimension such as *h* of, say ¾ inch (see sketch *F*, Fig. 7), a 7- by ½-inch wheel of 46–H grade and grain would be about right for grinding. First grind the lower horizontal surface to within 0.001 inch of the required depth; then insert a thin strip of steel between the workholder and straightedge of the chuck, in order to obtain the necessary clearance for the sides of the tool. Use the sides of the wheel to rough off the sides of slot *h* to within 0.003 or 0.004 inch of the width at the narrowest end (working face) of the tool, grinding first the left side and then the right side. Next, raise the wheel and grind off the top surface of *k* and also surface *N*, allowing 0.001 inch for finishing. Adjust

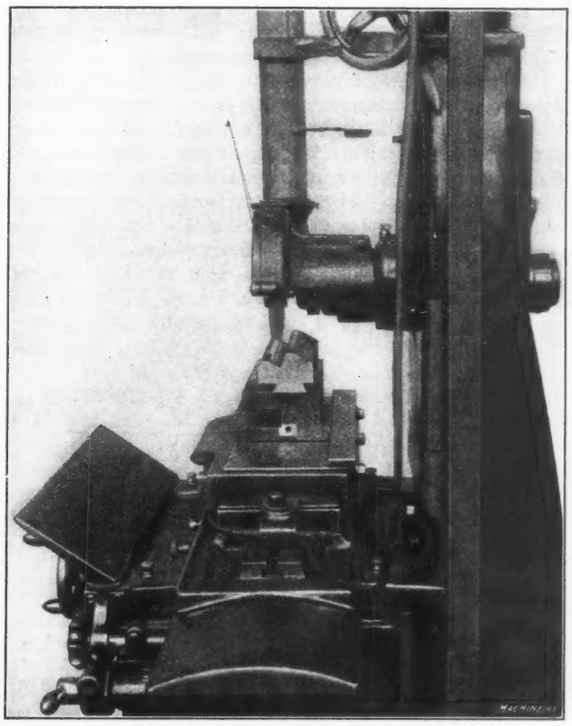

Fig. 6. Grinding a Hardened Forming Tool on Surface Grinder

the work laterally and rough off surface *o*; then drop to surface *M* and grind that to 0.001 inch less than the required depth. Next, raise the wheel far enough to clear the beveled corner to the left of *M*, and rough off the side surface, care being taken not to grind too much in order to retain dimension *g* at the narrow end, in proper relation to slot *h*. Be sure that the strip of steel is at the proper end of the fixture to allow a clearance on this side.

Now take a 6- by 5/16-inch saucer wheel (60-K) and dress off the face and sides, carefully retaining a sharp corner. With the fixture held as for the previous operation, grind the left side indicated by dimension *h*, great care being taken to grind it smooth and straight. While grinding, the lower edge of the wheel should be down even with the lower surface, and when the side is smooth, feed the wheel down far enough to take off the 0.001 inch from the lower surface that was left when rough-grinding; then feed the wheel to the right, thus finishing the lower surface as far as possible without touching the right-hand side of the slot. Note the reading of the handwheel dial and raise the grinding wheel one or two thousandths inch. Turn the fixture around, adjust the strip for clearance and then grind the other side of slot *h* until the required width is obtained. All measurements should be made at the working end or top face of the tool. Continue the grinding operation by feeding down to the same reading previously obtained and then feed horizontally to join the lower surface that was ground before turning the fixture around, thus finishing the slot.

Now raise the wheel and grind surface *I* and then side *o*, measuring from the slot *h*. Feed the wheel down far enough to take off the 0.001 inch left when roughing; then feed across surface *N* and the top surface of the part *k*. Turn the fixture around again and adjust the strip for clearance. Place a 6-

by ⅜-inch 46-K wheel on the machine and bevel off the left corner of the wheel so that the width of the chamfer is a little less than the width of chamfer *e-f* on the work. Dish the side of the wheel slightly, so that only the corner does the cutting (the same as a saucer wheel), and grind the remaining side of *g* until the width is correct; then feed down until the upper corner of the chamfer is ground to the right depth, after which move the wheel a little to the right and feed down, grinding horizontal surface *M* to the required dimension; then feed to the left until this horizontal surface joins neatly with the beveled corner.

Next dress off the back of a 60-K saucer wheel to the proper angle for side *c-d*, using the fixture for angular dressing illustrated in Fig. 9. (This fixture will be described later.) Make the face of the wheel slightly narrower than the width of slot *P* at the bottom; then with work-holding fixture inclined horizontally to give clearance to the side of the slot, grind the left side of slot *P* until *k* is of the required width, feeding down until slot *P* is of the proper depth. Raise the wheel slightly, remove the clearance strip and with the fixture set parallel to the travel of the table, grind the angular side, feeding laterally and down until slot *P* is of the correct width, when the index reading is the same as when finishing the other side. Care must be taken not to touch the straight side when grinding the angular surface, because the cutting edge would be the first to be ground away by the wheel, thus spoiling the tool. This slot can be roughed out with a coarser wheel, if desired, but should be finished with a 60-K to retain the sharp corners at the bottom. In this case, it is not likely that a roughing wheel would be economical to use, because changing wheels and forming or dressing two wheels would offset the extra time required for grinding with a 60-K wheel so as to prevent burning the tool. For this operation, a light touch with the diamond at short intervals counts when grinding the straight sides.

Next, secure a 46-K saucer wheel and form it for grinding the small round corners. The work-holding fixture should be set in different positions so that the same wheel may be used on all the corners of the same radius. The tool is now finished, excepting the beveled surface at the left and the left side. The beveled surface should extend a little below the largest diameter of the part to be turned, or, in this case, a little below the bottom surface of slot *h*.

In measuring a slot with the size blocks, insert the block or combination of blocks in the slot near the widest end and move them toward the working end of the tool as far as possible. Continue grinding from the side until the block will just pass through at the cutting edge. When measuring the width of a projection, the blocks may also be used by arranging them in the form of a snap gage, two extra blocks being used to form the gage jaws.

When forming tools were first ground by the Windsor Machine Co., a holder that swiveled was employed, but it soon became evident that this holder was unnecessary and, in fact, undesirable, owing to the time taken to change it back and forth, to say nothing of the possibility of a mistake caused by not getting it true for different surfaces. It is much preferable to have a plain holder like the one illustrated in Fig. 6 and then use a fixture to dress off the emery wheel to the required angle.

Grinding Angular Surfaces

The fixture used for dressing grinding wheels at an angle consists of a block which holds the diamond and is traversed back and forth on an inclined block; the latter, in turn, swivels on a stud at the center of the fixture, as indicated in Fig. 9, which shows the fixture applied to a surface grinder. The outer end of the inclined block rests on an adjustable screw, which, being movable in a slot, allows adjustment for any position from the vertical to the horizontal. There are two of these adjusting screws so that settings for two angles can be made at the same time, one on each side of the vertical. This swiveling block is set at any required angle relative to the top of the fixture, the top being ground parallel to the base. The fixture is about 4 inches wide, thus giving a good bearing surface for the bevel protractor. A vernier protractor can be set practically to within 2½ minutes of the given angle, and very few form tools require greater accuracy, although, for very fine work, the sine bar may be used in setting the swivel block. By using this truing fixture, one can dress a surface 1/32 inch wide just as accurately to a given angle as a surface 4 inches wide.

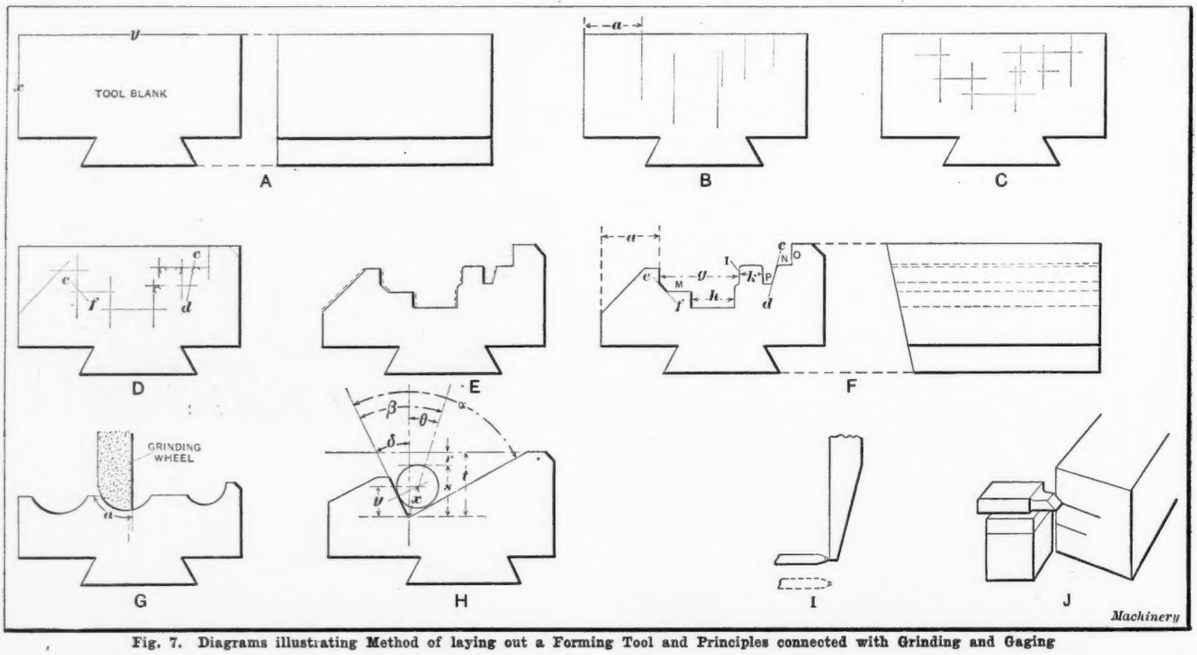

Fig. 7. Diagrams illustrating Method of laying out a Forming Tool and Principles connected with Grinding and Gaging

The grain and grade of wheels used for grinding surfaces on an angle are governed by the same condition as for straight grinding, except for a forming tool having two angular surfaces which, at the point of intersection, form a sharp corner as, for example, a tool for turning bevel gear blanks. For such work it is well to use a 46-M wheel; this wheel may seem too hard at first, but experience has shown that the best results are obtained with this grade. As little as possible should be left for grinding, and when using a wheel of the grade mentioned, it will rough out to within 0.001 or 0.002 inch of the size; then, after re-dressing the wheel, the surfaces may be finished smooth and a sharp corner obtained.

The best way to grind forming tools which are to be used for turning bevel gear blanks and similar forms is to take a 46-M wheel, say ½ inch wide, and dress it down so as to make the width of each bevel in proportion to the width of the surface each side is to grind. The bottom of the angular

groove is ground first by setting the wheel central, as indicated at *A*, Fig. 10, then feeding the wheel down and cutting to the full width of both bevels until the point of the wheel is 0.002 inch less than the required depth. To grind the remaining surfaces, raise the wheel and move it sideways so that when it is fed down again the wheel face will slightly overlap the surface already ground, as indicated by the dotted lines in sketch *B*. The wheel is then moved farther up the incline, and so on until the entire surface is finished. In a similar manner, the opposite angular surface is ground. For finishing, re-dress the wheel and repeat the foregoing operation, taking off the 0.002 inch left when roughing. If these

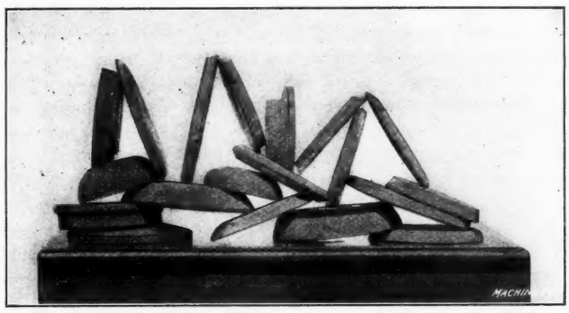

Fig. 8. Set of Grinding Wheels used for grinding Forming Tools

operations are performed carefully, a tool can be ground quickly without burning it, although it will become quite warm. This angular form of tool and those having large or irregular curves are the only ones that need a templet to work to, as all others can be gaged by direct measurement, using the graduated dials of the grinding machine and regular measuring tools.

When grinding sharp square corners, dress the face of the wheel off with a diamond attached to the magnetic chuck. When dressing the side of a wheel, the diamond should not be carried beyond the periphery of the wheel as indicated by the dotted lines in sketch *I*, Fig. 7, but should stop just before reaching the edge or in the position shown by the full lines, because the diamond breaks the corner of the wheel more or less if it passes beyond the periphery; therefore, it should be brought up close to the edge and then be returned. A little practice will enable one to grind sharp corners.

Gaging an Angular Tool

When an angular tool for bevel gear blanks does not have a curved surface in conjunction with the angular surfaces, a mechanic versed in trigonometry can save time by a few simple calculations. The diagram *H*, Fig. 7, illustrates how the depth of a V-groove can be accurately gaged by using a cylindrical rod and calculating the distance r to the top surface from which the measurement is taken.

For a tool of the form illustrated, the two angles and the distance t are always given. As depth t is down to a sharp corner, it is difficult to determine it by direct measurement, but by laying a cylindrical rod in the groove and measuring down to this rod, an accurate measurement may be obtained. As dimension r is the one required, the distance s from the top of the rod to the apex of the angle must be determined. As a rod lying in a V-slot will always center itself, a line drawn through the center of the rod and the apex of the angle will be equidistant from each side of the angle, thus giving the angle β which is one-half of angle α. A line drawn through the center of the rod and through the point of contact on either side of the angle will be at right angles to that side. This line, and the one extending from this point of contact to the apex of the angle and the line extending from the apex to the center of the rod, forms a right-angle triangle of which one side (radius of the rod) and angle β are known, so that dimension x may be obtained. (Hypotenuse equals side opposite divided by sine.) Drawing a vertical line through the apex of angle α and also one at right angles to this line through the center of the rod gives a right-angle triangle of which dimension y is desired. Angles β and δ being known, angle θ is easily obtained, and having dimension x, dimension y may also be obtained. (Side adjacent equals hypotenuse times cosine); therefore s will equal y plus one-half the diameter of the rod, and this dimension, subtracted from t, will give the required measurement r.

Points on Grinding Vertical Surfaces

When grinding the sides or vertical surfaces of a forming tool, any neglect or carelessness will be manifest in the action of the tool when it is being used. Care must be taken to see that the wheel is not allowed any side play when finishing vertical surfaces, as otherwise when the wheel leaves the tool at the end, it will grind the corners back on account of the gradual lessening of the wheel area in contact, thus forming a convex surface adjacent to the cutting edge. This will allow the stock, when the tool is in use, to rub on the side below the cutting edge, which causes a "loading" of the tool and makes it impossible to secure a good finish on the work. As this lack of clearance caused considerable trouble the Windsor Machine Co. adopted the plan of grinding a clearance on all straight side surfaces, to avoid any rubbing of the work or loading of the tool when in use. This clearance is obtained, as previously mentioned, by inserting a thin strip of steel between the edge of the grinding fixture, see Fig. 6, and the straightedge on the magnetic chuck, at whichever end of the fixture needs to be inclined outward in order to provide clearance for the cutting edge. This strip should be thick enough to provide a taper of about 0.008 inch in 3 inches, which is approximately the minimum amount for good results. While more clearance would be better as far as the cutting action of the tool is concerned, it would result in too great a change of length, as the tool is ground away on the top for sharpening. In most cases, however, a difference in length of 0.003 to 0.005 inch one way or the other is immaterial, especially on large work. Obviously, this liner

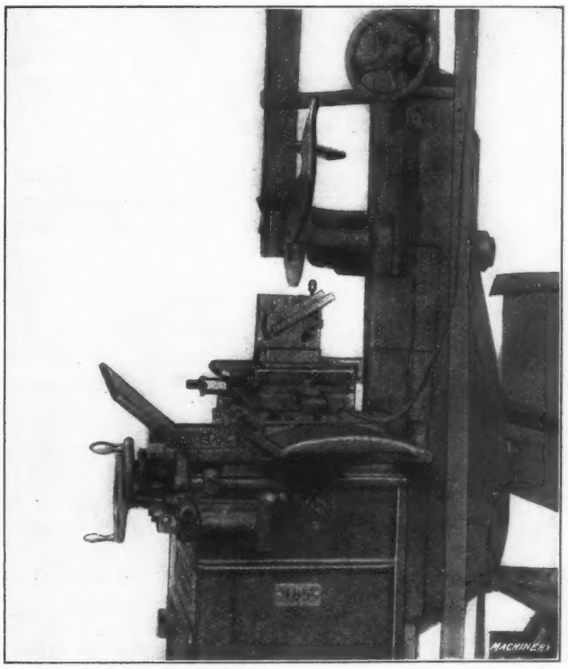

Fig. 9. Fixture on Magnetic Chuck of Surface Grinder is used for dressing Grinding Wheels at an Angle

can be inserted at either end of the holder, depending upon which side of the tool is being ground for clearance. This clearance is only necessary on straight sides, as all curves and surfaces on an angle, no matter how slight, will clear themselves. The only exception as to curves is when one joins a straight side; then it should be ground at the same time that the straight side is ground for clearance.

Joining a Vertical Side and Beveled Surface

Another grinding problem met with when finishing a forming tool similar to that shown at *L* in Fig. 2, is that of joining a straight or vertical side and a bevel, grinding the clearance on the vertical side and, at the same time, neatly joining it with the beveled surface. First, all the surfaces of the forming tool should be ground straight or without clearance; then a thin strip of steel, as previously stated, should be inserted to give the proper slant to the vertical side for

obtaining the necessary clearance. This, of course, will throw the bevel out of true so that the wheel, if fed down close enough to it, would grind at the bottom of this surface before touching the top or cutting edge. To overcome this, the working face or upper end of the forming tool should be raised enough so that when a test indicator, attached to the wheel guard, is run along the beveled surface, the pointer will remain stationary.

When finishing sides or vertical surfaces, the table should be traversed back and forth by hand, because a good surface cannot be obtained when the power feed is used, on account of

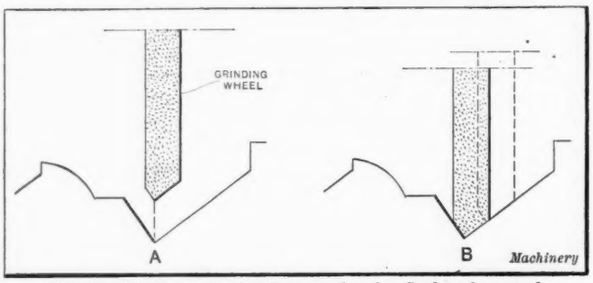

Fig. 10. Diagrams showing how an Angular Surface is ground

the jar of the mechanism when it reverses. When grinding ordinary forming tools, little difficulty will be met with if the mechanic adheres to the use of the grain and grade of wheels recommended in the foregoing, and bears in mind that this is an operation wherein the old saying, "haste makes waste" is especially true.

Grinding Curved Surfaces

The making of forming tools for producing irregular curves and surfaces is quite a different proposition from that of making tools having only straight and angular surfaces, and here is where experience in grinding tools is required, because these curves are affected by the clearance angle; hence, the curve on the wheel is not exactly the same as the curve to be reproduced on the work. Obtaining the required shape and size depends largely upon ones ability in dressing the wheel to the correct curvature by hand. For instance, when grinding a tool which is to have a circular cutting edge, the wheel is first dressed to fit a true gage of the required radius, and when finish-grinding the wheel face is slightly altered by hand dressing to compensate for the angularity of the cutting

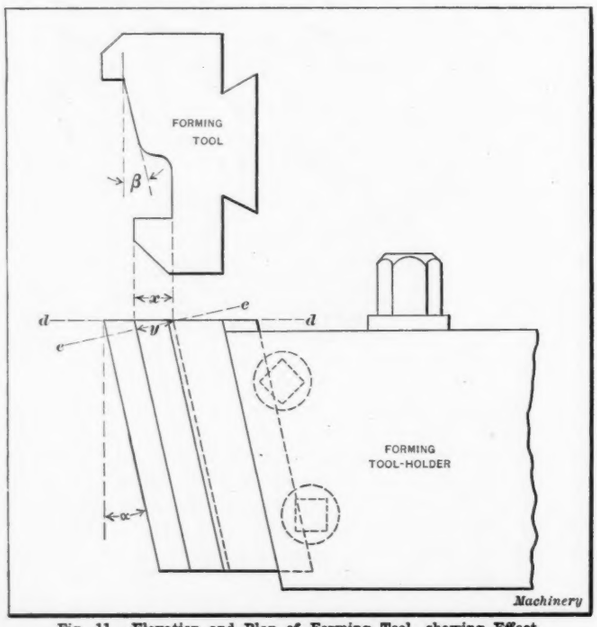

Fig. 11. Elevation and Plan of Forming Tool, showing Effect of Clearance Angle on Dimensions of Tool

face. In other words, it is necessary to make the wheel face slightly elliptical in order to secure a circular cutting edge along the beveled face at the top of the tool.

In grinding circular surfaces, it is advisable never to work on more than a quarter of a circle at a time because the work can be done more rapidly and better by following this rule. For example, to grind the tool illustrated at *G* in Fig. 7, the wheel should be dressed off so as to form a curve extending a little beyond the center at the bottom, as indicated by arrow *a*, to allow for joining the two halves of the surface neatly and smoothly. When grinding a curved surface of this kind, first grind one side and then note the dial reading on the machine. Next turn the holder around and grind the other side, feeding the wheel down to the same depth as shown by the previous reading. It is also necessary to feed the wheel laterally somewhat in order to compensate for the angularity of the top or working face of the tool. The form of the wheel must also be changed slightly in order to secure a true circle at the cutting edge.

As an example illustrating the grinding of curves of large radii, let us assume that a tool is to be ground and that the radius of curvature required on the work is 17/32 inch. Secure a partly worn 6- by 1-inch cup wheel of 46-I grain and grade and one that is a little wider than half the width of the curve. Dress off the wheel to fit a 17/32-inch radius gage and then grind one side of the curve as indicated by the diagram *G*, Fig. 7, just cleaning up the side. Next raise the wheel and turn the fixture around for grinding the other side. Move the wheel over, and down, gradually, to the same reading as shown by the dial on the handwheel of the machine. Doubtless this will not make the rough-planed recess either deep or wide enough, so that the wheel must be fed down, say 0.002 or 0.003 inch, and laterally proportionately. When making these adjustments the dial readings should be noted. Now raise the wheel slightly and turn the fixture around again; then by moving the wheel over and down, the first side should be ground until the dial registers the same as for

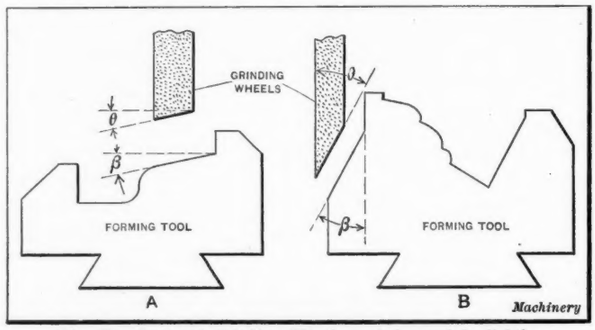

Fig. 12. Angle of Grinding Wheel must be varied slightly owing to Clearance Angle of Forming Tool

the other half of the curve. This operation must be repeated until the required depth is obtained, care being taken to keep the center of the curve in the proper place. The wheel must be dressed off at intervals for grinding the proper shape so that the cutting edge in the plane of the working face of the tool will be a true radius. All gages or templets for irregular surfaces and curves should be made to correspond with the curve required on the work and be held in the same plane as the working face of the tool, or, in this case, on a slant of 12 degrees, which is the required angle of clearance. No allowance should be made on the gage, the latter corresponding to the measurements required on the work and the tool being ground until the gage accurately fits the cutting edge, when held parallel with the top or working face. While the wheel should be dressed to the required form with a diamond tool, the following trick is often worth knowing: After the curve on the work is ground approximately to shape and size, secure part of a broken 46-K emery wheel, and using a flat surface, run this piece lightly back and forth once or twice over the working face of the wheel. Coarse emery cloth may also be used. As this operation dulls the wheel face, it must not be done until the tool is ground almost to the finished size; moreover, one must not attempt to secure the correct shape by dressing the wheel in this way. As previously mentioned, the shape should be obtained by dressing with the diamond tool, and not more than 0.001 inch be taken off the tool after the emery wheel is smoothed with the emery brick. If there is a greater allowance, the tool is likely to be burned, when grinding with the dulled face of

the wheel. When grinding curves, the wheel, as it does not feed laterally as in flat grinding, leaves fine scratches, the coarseness of which depends on the grain of the wheel; therefore a piece of emery wheel or cloth is used on the wheel prior to the final finishing operation, merely to obliterate these scratches. Ridges, however, cannot be ground out with a wheel that has been dulled in this way.

Grade and Grain of Wheels for Grinding Curved Surfaces

When grinding curved surfaces, the grade of the wheel should be varied according to the radius of the curvature. For all radii above ¼ inch, the use of a 46-H wheel is to be recommended. Although this grade is a little harder to shape than a softer grade, and secure a smooth surface, it will cut free without glazing or losing its form. For comparatively small radii, however, this grade will not hold its shape very well, and a 46-K is much more serviceable down to a 1/32 inch radius. For a 1/32 inch or a 1/64 inch radius, No. 46 grain is too coarse for good results and a grain and grade of 60-K should be employed. For rapid grinding, 46-H wheels should be used on all broad surfaces such as those illustrated at *C*, *F*, *I* and *Q*, Fig. 2. This grain and grade of wheel should also be used for grinding sides or vertical surfaces whenever a sharp corner is not required, and even then it is well to rough-grind with this wheel, finishing with a finer wheel. A grain and grade of 46-K gives a good finish when a small radius is to be left in a corner, but if a sharp corner is necessary, a 60-K wheel should be used, care being taken to keep it from glazing. If the wheel is touched frequently with the diamond tool, it will last longer than if allowed to glaze over excessively.

Vertical Forming Tool Calculations

The vertical forming tool, as used on the Gridley automatic, is held on a 12-degree angle for clearance, but when grinding, the tool is held horizontally (as shown in Fig. 6) so that it is necessary to make an allowance on all radial as well as angular measurements because there is a difference in the distance from one step to another on the tool, or a slight change in the angle, depending upon whether the measurement is taken along the top face of the tool or at right angles to the front face. To illustrate, if dimension x, Fig. 11, represents the distance that is to be reproduced on the work, it will be necessary, when grinding the tool, to make the depth y, measured at right angles to the front face, slightly less than the required depth x, owing to the angular position of the tool. Evidently the difference between x and y will depend upon the clearance angle a. The depth of y will equal dimension x multiplied by the cosine of angle a, or the side adjacent equals the hypotenuse times the cosine of a. For example, the part made with the tool shown at *C*, Fig. 2, should have a radius difference of one inch from the body part to the outside of the flange produced by the slot in the tool. As the top face of the tool is at a 12-degree angle while grinding, the slot should be ground to a depth equal to the radial dimension required on the work, times the cosine of 12 degrees, or $1 \times 0.9781 = 0.9781$ inch, instead of one inch.

Allowance must also be made when grinding angular surfaces. For example, suppose the angular surface of the forming tool illustrated in Fig. 11 is to reproduce an angle β of 15 degrees on the work. It is evident that in order to grind the tool to an angle β of 15 degrees on the top or along the cutting edge, the angle at right angles to the front face of the tool must be slightly less, owing to the clearance angle. For instance, if angle β is to be 15 degrees when measured in the plane *d*—*d*, the angle when measured along the plane *e*—*e* (which is square with the front face) will be a little less than 15 degrees and will represent the angle to which the face of the grinding wheel should be trued. The change of angle will, perhaps, be more clearly illustrated by holding an ordinary triangle vertically and then tipping it while the base is held in the same position.

To determine the angle at which the tool must be ground, multiply the tangent of the angle required on the work by the cosine of the clearance angle; the product equals the tangent of the angle when measured at right angles to the front face of the tool. Thus, taking the tangent of 15 degrees, which is 0.26795, and multiplying by the cosine of 12 degrees, or 0.97815, we have $0.26795 \times 0.97815 = 0.26209$, which is the tangent of 14 degrees 40 minutes nearly; therefore, the grinding wheel should be dressed to this angle.

For angles larger than 45 degrees, it is preferable to work from a vertical line, or from a line at right angles to the axis of the work, instead of parallel to the axis. When working from a vertical line, divide the tangent of the required angle by the cosine of the angle of clearance, instead of multiplying, in order to obtain the tangent of the angle measured at right angles to the front face of the tool. The difference between the two methods is illustrated by the diagrams *A* and *B*, Fig. 12. When angle β is measured in the plane of the top face of the tool and from a horizontal line parallel to the axis of the work (as at *A*), angle θ of the wheel face equals tan $\beta \times$ cosine of clearance angle. On the other hand, when angle β is measured from a vertical line at right angles to the axis of the work (as at *B*), tan θ of the wheel face equals $\dfrac{\tan \beta}{\text{cosine of clearance angle}}$. Suppose angle β (sketch *B*) is 30 degrees; then, dividing the tangent of the required angle by the cosine of the clearance angle, we have: $\dfrac{0.57735}{0.97815} = 0.59024$, which is the tangent of the angle the wheel should be trued to, or approximately 30 degrees 33 minutes. Thus, we have the following very simple rules for obtaining grinding angles or the angle of the tool measured at right angles to the front face:

When working from a vertical line (at right angles to axis of work) the tangent of the grinding angle equals the tangent of the angle of production (angle required on work) divided by the cosine of the angle of clearance. When working from a horizontal line (parallel to axis of work) the tangent of the grinding angle equals the tangent of the angle of production, multiplied by the cosine of the angle of clearance.

* * *

VANADIUM STEEL FOR HAMMER PISTON RODS

Probably no other machine part is subjected to greater vibratory stresses tending quickly to cause fatigue to the metal and resulting failure, than steam hammer piston rods. In such service the dynamic strength or anti-fatigue properties of the metal are put to the extreme test, and frequent failures of steam hammer piston rods are a common source of trouble and expense in all forge shops. As a solution of this trouble many forge shops have turned to the use of heat-treated alloy steels in order to provide the qualities which ordinary carbon steel piston rods so evidently lack. Heat-treated vanadium steel has proved to be particularly well adapted to this purpose, because of its high dynamic strength and durability, it having been shown by repeated tests to be superior to nickel steels for this service. The A. O. Smith Co., Milwaukee, Wis., well-known manufacturer of automobile parts and drop-forgings, has equipped all its steam hammers with vanadium steel rods. Twenty hammers are operated in this forge shop, ranging from 1000 to 16,000 pounds drop. These were fitted with chrome-vanadium steel rods, oil-treated, having the following physical properties: elastic limit, 80,000 pounds; tensile strength per square inch, 100,000 pounds; elongation in two inches, 20 per cent; reduction of area, 45 per cent.

The Obenberger Drop Forge Co., Cudahy, Wis., another well-known manufacturer of automobile drop-forgings, also has had satisfactory results from the use of heat-treated vanadium steel steam hammer piston rods. The company had been using 40-point carbon steel rods which were breaking and being replaced on an average of one every two months. As a substitute, 3½ per cent nickel steel was tried out, but with no better success. A heat-treated chrome-vanadium steel rod was applied to a 1500-pound open frame hammer in April, 1910. This operated continually night and day until November, 1911, giving a service of over a year and a half. On the failure of this rod, a 3½ per cent nickel steel rod was applied which lasted only twenty-four days. The rods were 5 inches diameter, 94 inches over-all, with a head having a diameter of 12 inches and a thickness of 4 inches.

INTERESTING MILLING ATTACHMENTS

BY LEIGH J. RODGERS*

Recently we had the job of making several dozen worms and worm-wheels of the following dimensions: 1 15/16 inch diameter, four left-hand threads per inch, 1¾ inch long to mesh with a 61-tooth gear; 1 13/16 inch diameter, two double threads per inch, 1½ inch long to mesh with a 31-tooth gear. Chasing the threads of the latter worm in a lathe is, at best, a slow, painstaking operation, and would probably result in a few torn threads if done by anyone except an expert lathe hand. So it was decided to mill the threads.

A Thread Milling Attachment

We had just completed a rack cutting attachment for a No. 1½ milling machine and had on hand an old pair of centers which required very little change to rig up ready for use. This rack cutting head is so simple and efficient that a few words of description may be of interest. The driving gear is of hardened tool steel 10 pitch, 14 teeth, 45 degree spiral, keyed on the regular 1-inch arbor. On each side of this gear is a hardened and ground collar accurately fitting the 2⅜-inch hole. The driven gear is of tough bronze, has 11 teeth and is keyed on the hardened and ground cutter spindle which is 1 inch diameter and has a bearing 6½ inches long with fiber thrust collars and fine thread adjusting nuts. This head has seen some hard service without appreciable wear or trouble of any kind, and would be found useful in any shop. The driving or work spindle of the centers extends back far enough to gear direct to the longitudinal feed-screw.

The regular milling machine feed-shaft having two universal joints was attached to a pinion meshing with the large spur gear shown at the front of Fig. 1. This pinion had its bearing in an angle-plate bolted on the milling machine platen (not shown). This arrangement gave us a choice of sixteen all-geared feeds, driving the work spindle through a pair of spur gears and worm-gearing as shown. The table was swiveled to suit the thread angle which, in the case of the double-threaded worm, was 5 degrees 4 minutes and geared up with a 48-tooth gear on the work-spindle and a 24-tooth gear on the feed-screw, with two idlers between, since the center distance was too great to mesh the 48-tooth gear directly into the 24-tooth gear. (The left-hand threaded worms had to turn opposite to the right-hand feed-screw.) In the case of the double-thread worm, the first method was to mark the gears, disconnect, move the work-spindle around 24 teeth, or exactly one-half revolution, and throw the gears in

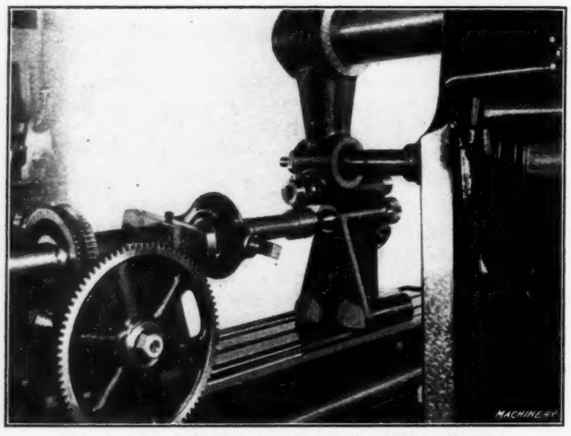

Fig. 1. Thread Milling Attachment for Milling Machine

mesh again. Later it was found that we could divide the thread very accurately, using the dial on the feed-screw. With a stream of oil on the carbon steel cutter, a good clean job without chatter was produced in ten minutes each.

A Hobbing Fixture

As one can easily guess from reference to Fig. 2, this hobbing fixture was built from pieces selected from the junk pile. The main casting was surfaced top and bottom, and a 2¼-inch hole was drilled and reamed through it. Into this hole was fitted a hardened and ground spindle having a bearing about 5 inches long and a thrust collar to bear on top of the base. The main or driven gear has 61 teeth that were carefully cut on the dividing head with the table swiveled to an angle of 5 degrees, 4 minutes. The driving worm has two double threads per inch. Both worm and worm-wheel were keyed on their respective shafts. Now to hob a 61-tooth worm-wheel blank for a single-threaded worm, it was only necessary to gear up as shown with a 24-tooth gear on the machine arbor and a 48-tooth gear on the fixture spindle, using an

Fig. 2. Crude Looking but Serviceable Hobbing Fixture

idler. The blank was then moved in until the hob began to cut, with the dial set at zero, and then fed in slowly until the proper depth of tooth was secured, as shown on the machine dial. While the fixture as shown worked fairly well, the cut could not be crowded owing to the springing of the work. It was found best to true up the blanks at point *A* and support the work with a heavy rigid rest, bearing at that point.

To cut the 31-tooth worm-wheel, it was only necessary to put the double-threaded hob and 61-tooth gear on the machine arbor and a 31-tooth gear on the fixture, driving the worm spindle with an idler as before. In a school shop, it is no drawback to have to build simple home-made tools that will embody the principles of the best special machines and accomplish the desired results. In many cases the interest aroused in the mind of the young mechanic, and the inventive reasoning developed by this type of problem, fully compensates for the lack of an expensive special machine in the equipment.

* * *

FANS VS. FIRE

We have all heard of fighting fire with fire, but the use of electric fans as an adjunct to a fire department in putting out a blaze is surely novel. In Boston not long ago a fire broke out in the basement of a building occupied by a wholesale paint and chemical concern. The fumes and smoke became so thick that it was impossible for the firemen to enter the basement or direct a stream with any effectiveness, when someone thought of electric fans. A half dozen of the ordinary sixteen-inch size were quickly requisitioned by the fire chief and their breeze directed down the stairway. As soon as the rear basement windows were broken to allow the escape of the smoke and fumes, the fans gradually cleared the basement so that the firemen could work quickly and effectively in extinguishing the flames.

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THE EFFECT OF DESIGN ON THE COST OF MACHINING

POINTS NECESSARY TO CONSIDER IN THE DESIGN OF MACHINERY IN ORDER TO REDUCE THE COST

BY ALBERT A. DOWD*

THE influence of the design of any mechanical device, whether it be a tool, fixture or machine, on the ultimate cost of machining its parts is a point that should be carefully considered by the designer. The effectiveness of any piece of mechanism must obviously be the first consideration in the design, but the mechanical operations necessary to manufacture the parts should also be carefully studied in order to minimize the cost of production to as great a degree as is consistent with efficiency. Much depends, of course, upon the general character of the work to be designed, and the varied requirements placed on the product. For example, in machine construction the convenience of operation in the finished product should never be sacrificed out of regard to problems of machining, nor should strength and rigidity be lessened in any way in order to facilitate the handling. In automobile construction, weight, strength, convenience and even general appearance are important factors which must be considered in the design, and all machining problems must be to a certain extent subservient thereto. So also in other lines of mechanical work, the requirements differ according to the purpose for which the devices may be intended.

In the design of special tools and fixtures, the cost element of the tool itself depends upon entirely different factors. In fact, the cost of tools and fixtures for rapid production work, when quantities are large, may be almost neglected, providing an elaborate equipment will increase the production sufficiently to warrant the expenditure, and also providing

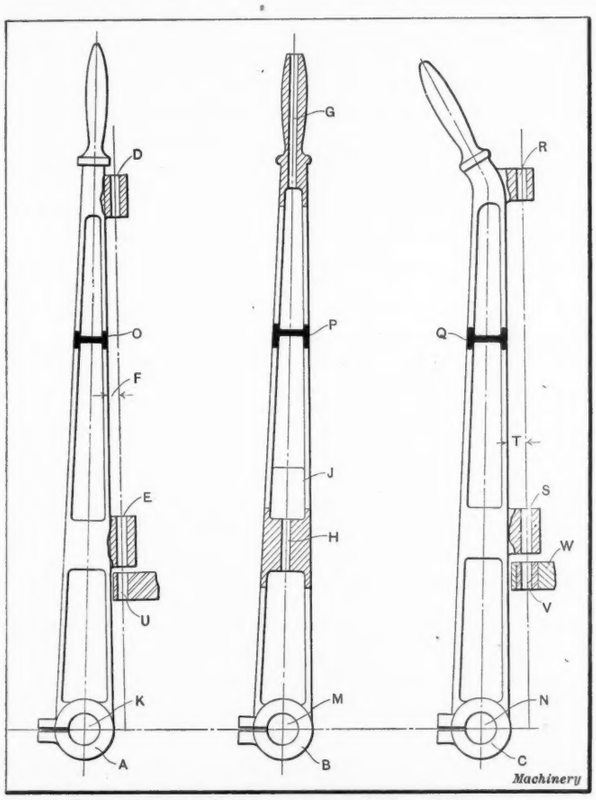

Fig. 1. Various Designs of Levers, showing Difference in Accessibility for Machining

that the design is such as to permit upkeep and replacements at a minimum cost.

A General Case of Design Considered

The designer naturally considers finished surfaces, bearings, drilled and tapped holes, grooves, recesses, etc., with a view to the possibilities of machining, but he seldom considers the matter from the viewpoint of economy. His analysis of the problems as they come up in the design is something like this: Can it be machined? How? On what machine—drill press, milling machine, turret lathe or boring mill? Can the parts be assembled without difficulty? How? Having satisfied himself that it is possible to machine the

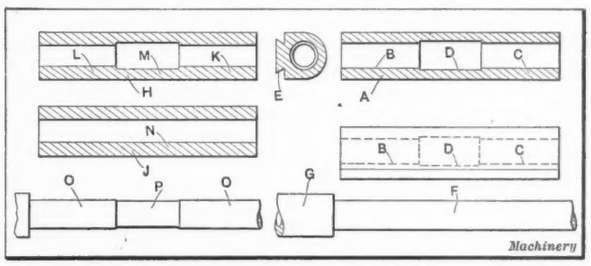

Fig. 2. Sleeve with Machined Recess which greatly increased the Cost

work on some of the standard machine tools, he does not consider it necessary to go into the subject further, unless he has been a shop man or tool designer, or perhaps both. If this is the case he automatically considers the machining problems in a more thorough manner on account of troubles which he may have encountered when connected more intimately with the actual machining processes.

During the progress of the design, the chief draftsman, superintendent, or someone else in authority looks over the work from time to time and passes upon it, occasionally bringing up the matter of machining certain portions which may be a little out of the ordinary, and making suggestions regarding the work as a whole. The machining problems are seldom taken up carefully in detail, unless something very much out of the ordinary is apparent, such as radial boring operations or a multiplicity of angular surfaces or some other matter which is likely to require expensive tooling, in which event the questions are more carefully considered. After suggested changes have been made, the drawings are approved, traced, blueprinted and sent out into the factory. Several days after this the patternmaker appears on the scene to inquire whether certain small changes (affecting the making of the pattern and its removal from the sand) will be permissible. Other questions having to do with coring, draft, partings, finished surfaces, etc., are also brought up at this time and they may or may not affect the design. As a general rule, however, the patternmaker can find a way out of a pretty difficult situation without causing any vital changes in the design.

Patterns having been completed, a trial casting is made and sent into the factory for machining, being completed in due course of time and tested out under working conditions. Having been found to work satisfactorily, with some minor changes which are incorporated on the drawings, it is decided to build a lot of, perhaps, fifty machines, if the work is a machine tool. In a case of an automobile, however, the lot may run from 2000 to 50,000 or even more, depending on the production of the firm manufacturing the product.

The tool designer now takes the matter in hand and decides on the sequence of operations and tooling required to complete the work. Let us now take up and look into the problems of machining from his point of view and see what may be required. Let us also note as we proceed points in the design which involve unnecessary cost in the machining and which might have been foreseen by the designer had he given more thought to this part of the work, or had he taken the matter up with the tool designer during the progress of his own work.

The first question to be decided is that of holding the casting for the first operation, and it is quickly noted that no provision has been made for clamps or lugs by which the work can be secured. Suitable lugs are therefore added to

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the pattern so that the casting may be firmly clamped in a fixture. This necessitates the return of the pattern from the foundry and a delay of a day or two while the needed changes are being made. The lugs for machining are to be milled off after all the operations have been finished, so that this item adds somewhat to the cost as a whole. In this connection it is well to state that there are many cases where an indented surface can be provided in the casting for holding purposes, instead of protruding lugs which require an extra operation to remove. Indented surfaces may often be made to serve as well and may be incorporated in the design in such a way that they are neither unsightly nor troublesome. A considerable saving in the cost of production can be effected in this way, if the designer gives a little thought to the matter during the work on the design.

A recessed bearing was next encountered. This recess

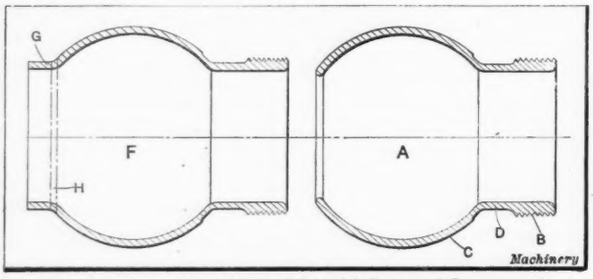


Fig. 3. Ball and Socket Pipe Joint with Suggested Improvement to facilitate Machining

called for finish, yet it was only an inch in diameter by two inches long. There seemed to be no good reason why it could not have been cored or a relieved shaft used in a straight hole. In order to machine the hole as called for on the drawing, it was found necessary to design a special recessing tool of somewhat delicate construction (on account of the small diameter), so that very light feeds were essential, making the production time correspondingly slow.

Two inside surfaces were next noted which were in such a position that back-counterboring seemed to be the only method by which they could be economically machined. On looking up the matter it was found that a slight change in their position would have permitted the use of an end-mill, which would have resulted in a saving both in tools and machining time.

There were several other points that required special methods of handling, which could have been saved by a little more thought on the part of the designer; for example, drilled and tapped holes close to the walls of the casting, so that extra long drills and special taps were needed; two small drilled angular holes on the same side of the casting having different angles of inclination, when the same angle would have answered for both. Several other minor points were noted which might have been differently arranged without sacrificing efficiency in the least, but which would have cheapened the machining processes considerably.

The tool designer now takes up some of these points with the designer, who considers them dubiously, with a view to possible changes. Meanwhile a number of castings have been made and are in the shop waiting for tools and fixtures with which to machine them. As the matter becomes known to the tool designer, he takes it up with the superintendent, making clear the improvement both in tool cost and production, if the suggested changes could be made. The superintendent hesitates to scrap the castings already made and therefore decides to use them, instructing the tool designer to go ahead on this basis, making provision for changing the next lot when designing the tools. The result is that the cost of special tools, fixtures, extra operations, etc., is much greater than it should be. In addition to this there is the cost of changing drawings, patterns, tools and fixtures after the first lot has been machined, together with the extra time required to design the tools so that they may be changed over to suit the new conditions, and at the same time making them so that they will be usable for replacement work in case breakages in the first lot occur. The far-reaching effect of design on the cost of machining is apparent in a case of this kind, as it is clear that greater care on the part of the designer with respect to the machining aspect would have resulted in a saving both in production time and in the cost of special tools. A consultation from time to time with the tool designer will be found of great value, as his familiarity with machining methods and problems allows him to note almost at a glance anything of a troublesome nature, and he may frequently be able to suggest a remedy for a difficult condition which will be thoroughly practical and which may be the means of saving a considerable expenditure. A few suggestions are herewith offered in connection with design which will tend to decrease machining costs if applied during the process of designing.

Points in Design which Affect the Cost of Machining

General shape of the work:—This is one of the first points to be considered, as it seriously affects the holding devices which may be necessary for the machining operations. After the design has been worked out sufficiently to determine the general contour of the various components, the question of holding and clamping should be considered, and provision made in the castings either by the addition of lugs or by indented surfaces. The latter are much to be preferred if the nature of the work will permit their use, as they require no extra operations such as might be necessary if lugs were to be removed after machining. If the work is of cylindrical shape such as might be machined on a turret lathe, the addition of a small driving lug may be found of great advantage, providing it can be applied in such a way that an extra operation for cutting it off will not be needed. Very little time is necessary in considering these points, but a little forethought at this stage may effect a considerable saving in the cost of machining.

Drilled or tapped holes:—It is advisable to use as few sizes as possible consistent with good design, and to avoid angular holes wherever practicable. Flange holes should be spaced far enough away from the sides of a rough casting to permit the drill press spindle to pass without interference, so that long special drills will not be needed. Special length drills are more expensive than the regular, and annoying delays are often caused by waiting for them to be made. If it is not possible to design so as to obtain spindle clearance,

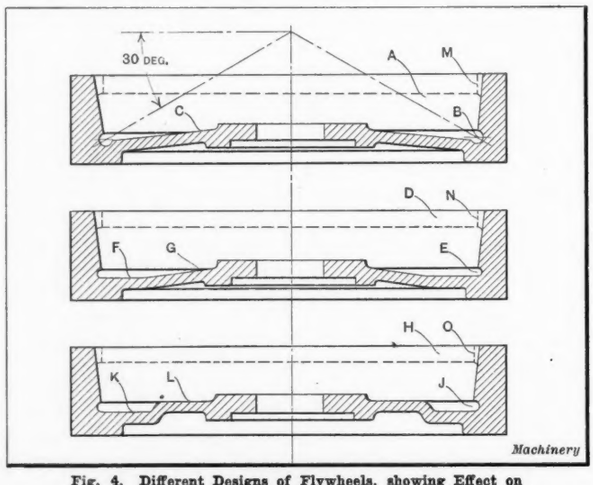


Fig. 4. Different Designs of Flywheels, showing Effect on Ease of Machining

space enough should be given so that supporting bushings can be used for guiding the drills.

Threaded work:—The expense of machining threaded portions of the work may easily be made to run into a considerable amount of money, unless care is used in the design. Threads of special pitch should be avoided as far as possible, so that special dies or taps will not be needed. Threads on either exterior or interior surfaces should be provided with a clearance groove if they run close up to a shoulder. Any threaded interior surface which must be concentric with a cylindrical adjacent portion should be made with a loose fitting thread so that the cylindrical portion

may perform the centering function. If the drawing calls for good fits on both portions, considerable difficulty will be experienced in the machining on account of the tendency of a tap to run slightly eccentric unless it is piloted.

Internal grooves or recesses:—These are frequently the cause of unnecessary expense when machining is called for, on account of the confined situations in which recessing tools are compelled to do their work. Complications in machining often arise on work of this kind which could have been avoided by the designer had he cored the recess so that finish would not have been required. This is not always possible, but should nevertheless be considered with a view to saving machining. The writer has designed a recessing tool which

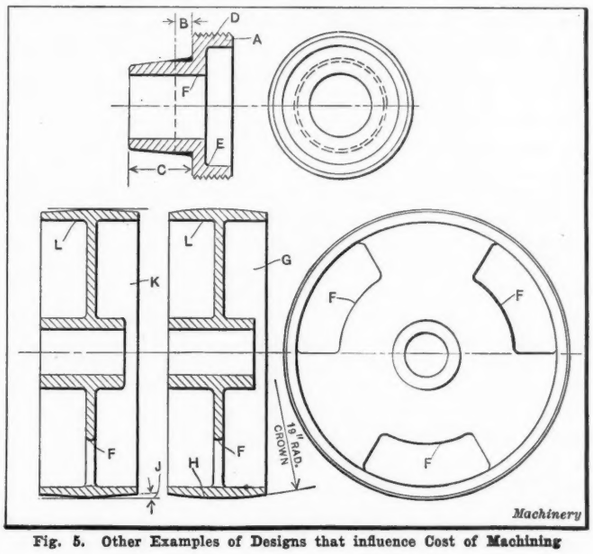


Fig. 5. Other Examples of Designs that influence Cost of Machining

cost about $75 to build for an internal finished recess which could have been avoided by a little more forethought on the part of the designer.

Internal finished pads or surfaces:—If internal finished surfaces are required, an effort should be made to arrange them in such a way that they may be milled off without the use of special mills. Inside bosses are often arranged so that an operation of back-counterboring is necessary, which is both troublesome and expensive. In addition to this, the accuracy obtained is usually far from satisfactory. Whenever these surfaces can be so arranged that they may be milled, the results will be found much better from all points of view.

Angular surfaces:—These generally require an extra operation in machining, and as the expense of an extra operation with its fixture is an important item, it should be avoided as far as possible. Frequently an outside angular surface on a large casting may be made perpendicular to the other surfaces by designing the bracket or other component which matches with it in such a way that the angular surface will come on the smaller casting, for which a fixture can be made at much less expense. The matter of angular surfaces should always be carefully considered so that the cost of special fixtures will not be excessive.

A Few Examples Illustrating Machining Costs Influenced by Design

A few examples which show the effect of design on the cost of machining are given herewith and are for the most part drawn from the writer's own experience. Nearly all the examples given are of a simple nature, but illustrate as well as if more complicated the value of forethought in designing.

Fig. 1 shows at *A*, *B*, and *C* three types of automobile hand-levers, all of which are drop-forged, and which require more or less machining. The drilling of the holes which act as bearings for the operating rods is affected to a considerable extent by the position of these bearings, and although this seems but a small item in the general expense, it will serve to illustrate several points worthy of attention. In the lever *A*, the position of the holes *D* and *E* is such that there is insufficient room for drill jig guide bushings, so that it becomes necessary to use a tool steel plate for the purpose, as shown at *U*. Another bushing of the same kind must also be used at *D* for the other bearing, which is some distance away. As bushing plates of this kind give no chance for replacement, except by making entirely new plates in cases of breakage, and as the amount of stock around the hole is very small, it will be seen that the expense of upkeep might be of some moment. The delay in production while waiting for the jig to be repaired might be even more costly. Special length drills would naturally be required for this work, but this seems unavoidable in this instance. The distance *F* is really the cause of much unnecessary expense and delay, and a slight change in the design would have obviated it all.

The lever *B* is also a drop-forging having a section as shown at *P*, slightly more offset than *O*. The design in this case has been considered with a view to machining the holes *G* and *H*, as the pocket at *J* is evidently so made that a supporting bushing can be located in the jig at this point.

Lever *C* has a section *Q* similar to *O*, but the distance *T* is sufficient to permit a better construction for the bushing, as indicated at *V*. The offset handle also allows the use of a shorter drill than in the other instances, and the drilling can be done from the handle end if desired. The three examples given have as their locating points the holes *K*, *M*, and *N*. The conditions represented here are of the simplest kind and the expense incurred is comparatively slight, but it must be remembered that a number of instances of this kind would add a very appreciable amount to the cost of machining.

A situation which involved much greater expense and which could have been readily avoided is shown in Fig. 2. A bronze bearing *A* is machined at surfaces *B* and *C*, which act as the bearing surfaces for the shaft *F*, which has a diameter of ⅞ inch. A recess is called for at *D* with a diameter of 1/32 inch more, and this recess is to be finished. A straight hole was cored in the piece and it was roughly chucked out on a special fixture on a hand screw machine, being located by the dovetailed portion shown at *E*. A small horizontal boring mill was used for finishing the hole and for the recessing operation, an accurate alignment with the dovetail being essential. On account of the small size of the hole the design of the recessing tool was somewhat troublesome and its construction both delicate and costly. The upkeep of the tool was also expensive and its operation slow on account of its delicacy, making the cost of the recessing operation excessive.

Prior to the designing of tools and fixtures for this piece the matter of recessing was taken up with the designer, on account of the expense of tooling, and an endeavor was made to have the pocket cored as shown at *M*, leaving the two holes *K* and *L* to be machined, thereby doing away with the necessity for a recessing operation. An alternative suggestion was also made, that the hole be made straight as indicated at *N*, and the shaft provided with bearing surfaces *O* and a relief *P*. Neither of the suggestions met with favor, and the design was left as at *A*. As there were twelve of these pieces on each machine built, it may readily be seen that the cost of machining was very materially increased.

An example which illustrates the value of provision for chucking is shown in Fig. 3. At *A* is shown a portion of a ball and socket pipe joint which was to be machined at *B* and *C* on a turret lathe. Several machines were ordered with the necessary equipment to produce the work, and a number of sample castings sent along with the order. The firm for whom the work was being done was located nearly half way around the world, so that changes in patterns were out of the question, and the castings had to be handled just the way they were. So much time would have been lost in obtaining consent to make desirable changes, that the entire contract would have been lost. It was found necessary to machine the work in two settings, and to make special holding devices for both of these, thereby causing much loss of time in machining, in addition to the cost of the equipment.

Had the designer considered the machining he might easily have supplied a supplementary ring by which the work could have been held and machined complete in one setting. The addition of such a ring as that shown at *G* on the redesigned casting *F* would have permitted the use of a set of metal-to-

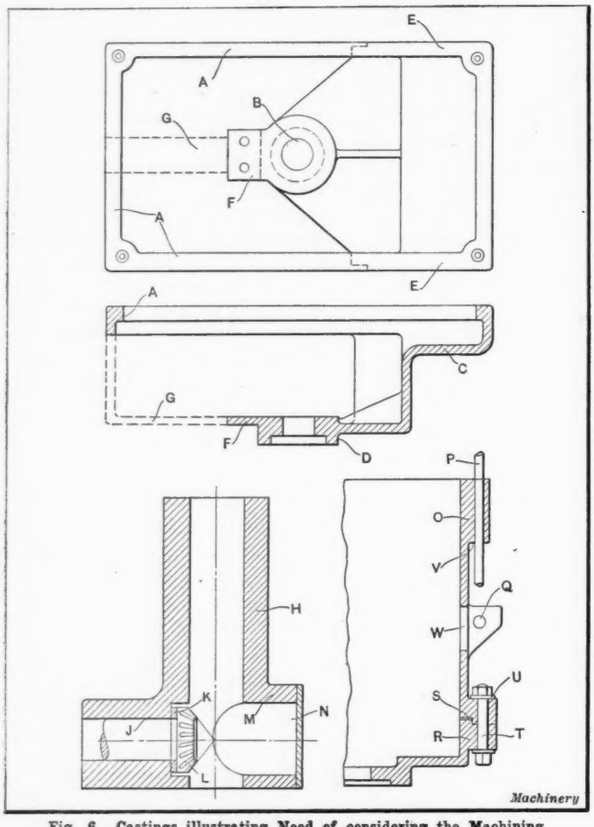


Fig. 6. Castings illustrating Need of considering the Machining Problem when designing

metal hook-bolt jaws at this point, leaving the other portions of the piece free for machining, so that all the work could have been easily done in a single setting. Then, after its completion, it would have been a simple matter to cut off the supplementary ring at *H*, leaving a casting machined in not much more than half the time necessary for the original design, and involving only the loss of the chucking ring *G*, the expense of which need hardly be considered.

Flywheels for gas engine work are usually finished all over on account of the high rate of speed at which they are to be run, which necessitates a perfectly balanced wheel. Several designs for a 16-inch clutch flywheel of this kind are shown in Fig. 4, and attention is called to the differences in design which affect the machining. Essential points in the machining are that the shouldered hole, the small hole and the clutch taper must be concentric and true with each other. It is usually advisable, therefore, to hold the work by the inside of the tapered portion and machine the shouldered and small hole first, together with the web, rims and periphery. A chucking ring should therefore be provided at *M*, as it would not be found practical to hold the work by the taper. In the second setting the shouldered hole is the locating point, from which the tapered portion is machined. In the upper figure *A* it will be noted that a recess *B* is cut at an angle of 30 degrees, so that clearance for the clutch will be obtained. The machining of this recess calls for a special recessing tool or a hand operation in manipulating the feeds to obtain an approximation of the recess called for. The angular web *C* requires a forming attachment of some kind or else a hand operation subject to a certain amount of variation depending on the skill of the operator. Both the cutting of the recess and the machining of the angular web are somewhat expensive, and can usually be avoided.

In the example *D* the recess *E* is cut perpendicular to the axis of the flywheel and therefore may be readily machined without the use of special tools. The web is partially straight, as at *F*, and the remainder *G* is much narrower than *C*, so that it may be machined with a wide faced tool, and does not require the use of a forming attachment. The chucking ring *N* should not be forgotten. The machining of this piece can be accomplished much more quickly than *A*, and the cost of tooling is much less, due to the farsightedness of the designer and his consideration of the machining.

A step further in improving machining possibilities is shown at *H* in the lower figure. In this case the chucking ring is provided at *O* and the recess at *J* as in the last case, but all the angular work on the web is done away with, by using the two offset surfaces *K* and *L*. Attention is called to the fact that all these designs are made for the same purpose, but the difference in cost of machining is apparent.

Fig. 5 shows at *A* a malleable iron bearing sleeve which was made in two lengths *B* and *C*. The work was to be bored, reamed and threaded, preferably in one setting. In attempting to do this, however, it was found that the draft on the pattern was of such a taper that it was impossible to hold the work, even in a set of special jaws fitted to the taper. It became necessary, then, to make a preliminary operation of rough-turning a straight part on *C* of sufficient length to allow gripping in a set of straight jaws. There were several hundred castings on hand and this extra operation had to be performed on all of them, making the expense about 50 per cent higher. The pattern was, of course, immediately changed, but it was found that the real root of the trouble lay in the drafting-room, the pattern having been made to the drawing. This matter, of course, was an oversight on the part of the designer, who undoubtedly made it tapering to save weight and perhaps also on account of the appearance.

Another example of a piece of work which is more expensive to machine than is necessary, is shown at *G* in the lower part of the illustration. This is a cast-iron webbed pulley having three openings *F* in the web (which incidentally give excellent driving facilities) and a face *H* crowned to a circular arc. This method of crowning requires a radius turning attachment or its equivalent, and the work must be machined with a fine feed on account of the varying cutting

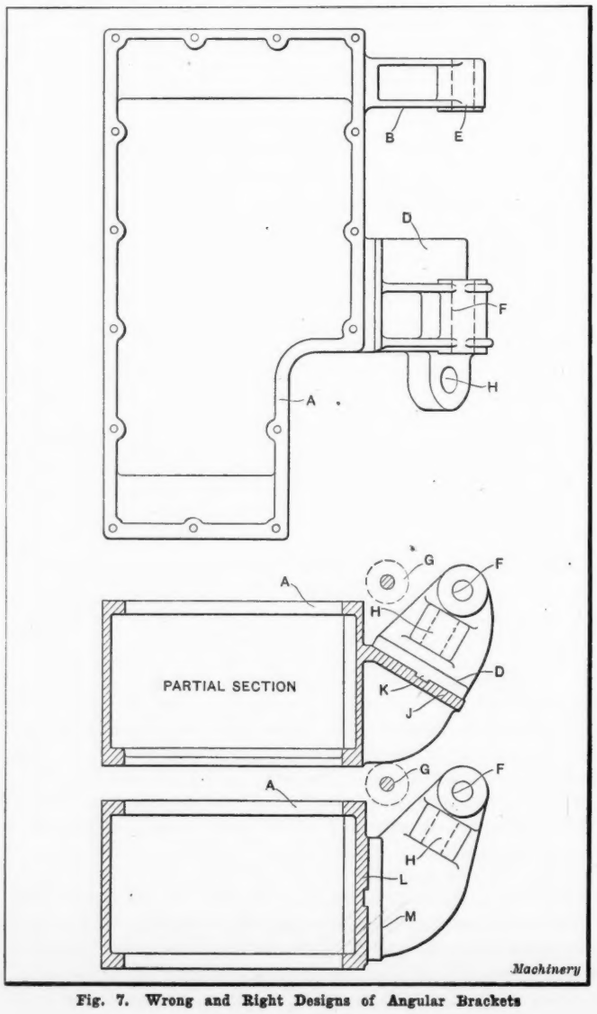


Fig. 7. Wrong and Right Designs of Angular Brackets

faces of the tool which are continually presented to the work. If fine feeds are not used in finishing, a series of ridges will be formed, which would be commercially unsatisfactory. If an angular crown is permissible, such as that shown at *J* on the casting *K*, heavy feeds may be taken both in roughing and finishing with a taper attachment, providing the tool is ground so that the cutting faces have a double angle corresponding to the crown of the pulley. Less than half the time is required for machining a pulley designed like *K* than is necessary for the arc-crowned type *G*.

An intricate aluminum casting of very thin section is shown in the upper part of Fig. 6; the shape of this piece and its fragile nature makes necessary the greatest care both in the design of holding devices to prevent springing, and in the machining itself. Reference to the illustration will show the "open-work" construction which was largely responsible for the excessive cost of the fixtures with which the work was produced. In the milling fixture for the flange *A* several floating clamps and adjustable jacks were found necessary in order to avoid distortion in the finished work. In the chucking operations a like amount of care was necessary on account of the unsupported portions *F* and *B*. The locating was also found difficult for the chucking operations because of the shallow boss *D*, while the milling of the thin lug *F* on the side requiring a shoulder was very troublesome. This casting was an exceptionally difficult one, and its construction was such that very little could be done in adding lugs for clamping. A stiffening angular brace was put in at *G*, but this was of little help. It is barely possible that the designer of this piece was forced by some unknown condition into making the parts as here shown, but the expense of the design is apparent, as are also the difficulties in machining. It would seem to the observer, without further knowledge of the conditions, that no thought whatever could have been given to the machining problems in designing.

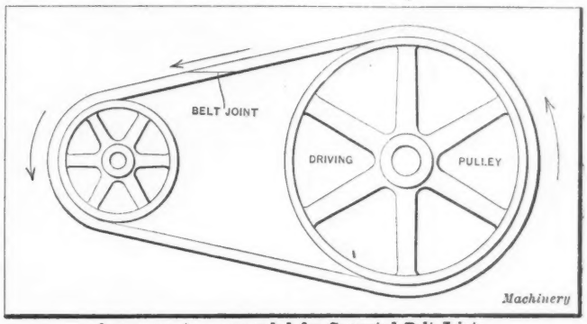
An example is shown at *H* which would have required a difficult back-counterboring operation at *K*, if the design had not permitted an additional hole *M* to be bored in the work so that the surface mentioned could be easily reached. This hole was afterward covered with a steel plate *N*. As the shoulder formed a resting place for the thrust washer behind the bevel pinion *L*, it was essential that it should be square with the bearing *J*, and this would have made a very difficult operation if machined by a back-counterboring operation. In addition to this, there would have been trouble in obtaining the correct center distance.

The partial section shown at *O* in the same illustration, with its mate *R* to which it is fitted at *S*, is an example of close drilling and facing. The surfaces *U* and *V* are very close to the wall of the casting, but are so situated that they may be easily faced with an end-mill. The drilled holes for *T*, *P* and *Q* are also close to the casting walls but their position and arrangement allow bushings to be placed in the jig at the necessary points, as *P* can be drilled from above, *T* from below, and *Q* has a recess *W* very close to it.

Fig. 7 shows in the upper view a plan of a machine component of rather light construction but fairly large size. It is provided with a bracket *B* which is a part of the casting itself, having a shaft bearing *E* in alignment with *F*. The bracket *D* in which the latter is located is a separate casting tongued at *K* to fit a slot provided for it in the angular support *J*, which is a part of the large casting. The dotted circle shows the nearest interference. The bearing *H* is situated at an angle of 30 degrees to the vertical. This entire bracket construction is expensive on account of the machining, for it will be noted that the angular surface on the large casting requires a special fixture for milling, while the bracket *B* might have been made as a separate piece instead of a part of the large casting. A construction such as that shown in the lower figure would have been much more economical to machine, and would have required fewer special fixtures. Attention is called to the fact that the finished pad *L* is at right angles to the other finished surfaces, so that one setting of the work or, at any rate, one fixture would be sufficient. The angular work is all in the smaller brackets which are much more readily handled, and the fixtures are cheaper.

CEMENTED BELT JOINTS

There is a wide difference of opinion as to the correct way of running belts with cemented joints. Diametrically opposite views have been expressed. In the *Travelers Standard* for August, the method shown in the accompanying illustration is recommended. The taper joint should be so placed with relation to the direction of running of the belt that when the belt passes over the pulley on which it is most likely to slip, there will be no tendency for the slipping pulley to pull the joint on the inside of the belt loose, and roll the scarfed end back, thus weakening the joint. When the loosened end rolls up in this manner, stresses are induced in the belt every time the joint passes over the pulleys, and these strains may be great enough to cause the belt to give way suddenly. In the illustration shown, the belt thickness is exaggerated in order



Arrangement recommended for Cemented Belt Joints

to show the joint more clearly. The pulley on the left is the one most likely to slip, because of the smaller arc of contact with the belt. Hence, the joint is arranged so that if this pulley slips there will be no tendency to roll back the scarfed end. Basing a general rule on this reasoning, it would read as follows: The leading point of the joint should be on the outside when the driven pulley is the smaller, but on the inside when the driving pulley is the smaller of the two.

* * *

TRADE IN RUSSIA

The Russian government has authorized the publication of a statement by its minister of foreign affairs, M. Sazonoff, relating to the possibilities for trade with the Russian empire. The article which has been published in the *Times* (London) states that at the present time there is an unusual opportunity for trade and commerce with Russia which means, to England and America, now and in the future, a great deal more than may be ordinarily believed. There is an enormous and lucrative market in Russia for machinery, chemicals and all kinds of manufactured articles. It is stated that the importations from Germany amounted to a grand total of $300,000,000 a year, and as the avenues of supply across the German frontier have now been cut, it is the business of the American and English nations to pave new ways for importation into the Russian dominions for their products. Sazonoff requests in the article mentioned that experts be sent to Russia even while the war is in progress in order to ascertain the requirements of the country and to study the means whereby these can be fully and successfully met. It should be understood that Russian trade generally must be "gone after," but it is there for whosoever is willing to take the trouble of doing so, and those manufacturers who look for foreign trade should arouse themselves immediately, deal firmly and intelligently with this question, and not miss the opportunity now presented for entering into a new and potential market. The sooner they acquire full knowledge of the needs and the extensive possibilities of trade with Russia, the better. Those that are first in this movement will reap a rich harvest.

* * *

Turning chilled cast-iron rolls for paper calenders is slow work. The turning speed when roughing is about ten to twelve inches per minute, six tools sometimes cutting at once. The finishing speed is higher, being about thirty inches per minute. The rolls are turned to within about 0.004 inch of the desired finished diameter when ground.

TWO USEFUL DRILL JIGS

The different types of special automatic machinery built by the American Machine & Foundry Co., 346 Carroll St., Brooklyn, N. Y., call for the use of a variety of bronze bearing bushings. These cover a wide range of sizes, and different bushings must have the oil-hole drilled in different positions. A universal drill jig is used for this purpose, front and rear views of which are shown in Figs. 1 and 2. Referring to these illustrations, it will be seen that the

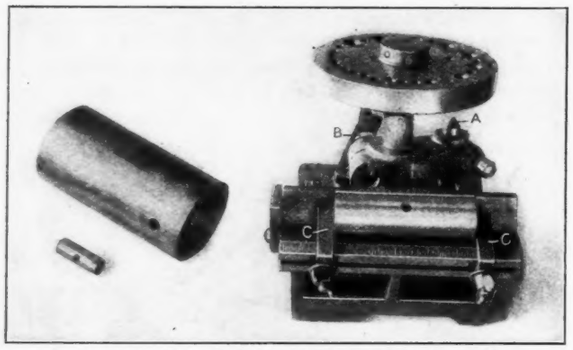


Fig. 1. Front View of Jig for drilling Oil-holes in Bushings

bushings for drilling different sizes of holes are carried in a circular plate that may be rotated on its supporting stud to bring the proper bushing into the operating position. This bushing is then located by the conical shaped pin *A* which enters one of the other bushing holes. It will be evident that the conical point on this pin enables it to center itself in all sizes of bushings. After the required bushing has been located in this way, the bushing plate is clamped by tightening the bolt *B*, which draws up the split bushing about the supporting stud.

Referring to the front view of the jig shown in Fig. 1, it will be seen that a scale is graduated along the front edge of the V-block in which the bushings are held, and that two gage blocks *C* are provided, which may be clamped in any desired position by means of wing nuts. By adjusting these end gages to the required positions, the jig may be set for drilling the oil-hole in the bushing in any position—either central or at a specified distance from one end. The bolt *B* holds the jig plate at any required height to accommodate a given size of bushing, but after the jig has been set for drilling the first bushing it is not necessary to loosen the bolt *B* to remove the work. This is more quickly accomplished by loosening the handle *D* shown in the rear view of the jig in Fig. 2. When this handle is swung back, the plate in which the drill bushings are mounted can also be swung back to clear the work, which may then be lifted out of the V-block. The jig illustrated is provided with bushings for drilling all sizes of holes from 1/2 down to 5/32 inch by thirty-seconds, and

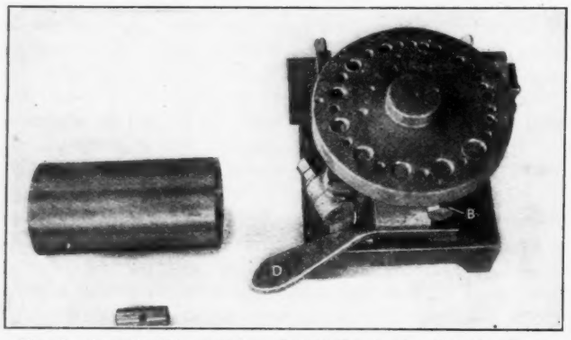


Fig. 2. Opposite Side of Universal Drill Jig showing Clamping Lever

has a capacity for handling a large range of work. The extreme sizes of bushings that can be handled in the jig are shown in the illustration, while a medium sized bushing is illustrated in position in the V-block. Many manufacturers who have a variety of bushings to drill could use a universal jig of this type to very good advantage.

Among the contract work handled by this company there is an automatic drill chuck, and in making the bodies of these chucks it is necessary to mill three slots at an angle of 120 degrees from each other. These slots are first drilled, after which they are finished with an end-mill. Fig. 3 shows the drill jig used for this purpose, and lying beside the jig is one of the blanks for the chuck body, and also a body after the slots have been drilled out preparatory to milling. In handling this work, the extension at the end of the chuck body fits into a socket *A*, after which the handle *B* is moved to the right to bring the opposite end of the work into contact with the rotating block *C*. This block has a jaw on it which engages the projection *D* on the work. It is necessary to drill five holes to form each slot, and this is done by moving the drilled bushing to consecutive positions by means of the handle *E*.

It will be seen that the scale *F* moves over an index point on the frame of the jig, and in this way the bushing is located for drilling each of the five holes. When located in any of the working positions, the handle *E* is pushed down to enter a stud into a hole in the frame of the jig, thus locking the bushing in place ready for the drilling operation. After the five holes for one slot have been drilled, the handle *G* is drawn back to release the index pin from the hole in the plate *H*, after which the handle is rotated to the next position in which the index pin enters the hole to locate the work for drilling out the next slot. The jaw which engages the

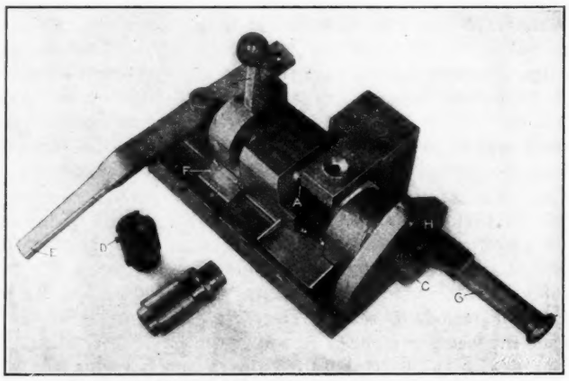


Fig. 3. Special Drill Jig used in machining Chuck Bodies

projection *D* on the work enables the work to be rotated in this way. When the work has been indexed, the five holes for the second slot are drilled according to the preceding instructions, after which the work is indexed a third time to provide for drilling the third and final slot. The accuracy secured with this jig will be readily appreciated when it is known that the limit to which the work must be finished is 0.001 inch.

E. K. H.

* * *

SAFETY FIRST AND MOTION PICTURES

The employes of the New York Central, Lackawanna, Santa Fé, and Burlington railroads are to be taught some of the principles of accident prevention by means of a moving picture exhibition including a love story. At first thought, says the *Railway Age Gazette*, one might think that this is a rather light and questionable treatment of a very serious subject, but love and tragedy are so skillfully combined that no one who has seen the pictures will question their effectiveness. The safety first movement is essentially one which depends on appeal to various emotions rather than to systematic commands and instructions, and arguments addressed to the emotions rather than to the intellect alone are, therefore, very successful. The men who will derive the most benefit from this method are probably the freight-train men, and it is from the everyday life of these men that the lessons shown have been taken. For general audiences the scenes are perhaps of a rather startling character, but for the men who work about trains and in freight yards, the lessons are none too vivid. Most of these men do not fully realize the percentage of their fellowmen who are killed or injured by carelessness each year.

A NEW METHOD OF POLISHING DIAMOND DIES

BY J. A. S.

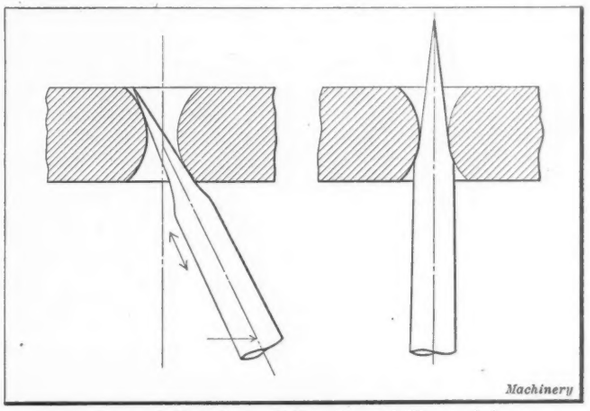
The draw-holes of diamond dies soon wear rough and non-circular and they have to be frequently reground to a polish in order to make them fit for use in wire drawing. As the drawing of fine wires has received a tremendous impetus since the introduction of the metal filament electric lamp, it may be interesting to direct attention to a new automatic machine and method for regrinding the diamond dies used for this purpose.

In the simplest machines hitherto employed for this purpose, a slim pointed steel pin or needle is rapidly pushed to and fro in the hole of the rotating draw-stone, to which an abrasive and polishing medium is applied. By placing the pin or needle at an angle to the axis of the stone, the draw-hole can be given a conical form similar to that required. It is, however, found that the correct form of the draw-hole when ground in this way, is often entirely destroyed because after each adjustment of the pin, only a small zone on one side of the draw-hole is ground. In order to improve this condition, the grinding pin is given a separate and positive movement relative to the axis of the hole by means of a more or less complicated mechanism; but even this, it is claimed, does not produce the desired result of maintaining the original conical shape of the hole in the die. The reason for this is that the guidance and rotation of the polishing pin-holder takes place about a given fixed point outside the draw-stone, and the lateral movement, for instance, is a compulsory one. The form of the draw-hole is, however, usually different in each case; sometimes it is long and sometimes it is short, and the position of the draw-stone perforation also varies because of different thicknesses of the draw-stone holders. In addition to this, it is frequently impossible to deflect the needle sufficiently from its central position because the pin would push the stone away from the disk to which it is only cemented by means of wax.

The regrinding of conical perforations in draw-stones has also been attempted by employing a wire drawn tautly through the perforation in place of the polishing pins. This wire, during the grinding operation, is moved to and fro in the perforation of the draw-stone which is caused to rotate and at the same time to make oscillations about its vertical axis. The difficulty of successfully grinding out fine perforations with even very hard fine grinding wires, from say 0.1 millimeter to 0.015 millimeter in diameter for the finest perforations, is evident, because the fine grinding wire has to sustain a certain tension and also the action of the sharp diamond dust has a tendency to cause the wire to break. Moreover, in grinding out holes which have become non-circular, it is difficult to keep such wires sufficiently taut to restore the true circle in holes which have worn out of truth. It is also claimed that the consumption of expensive diamond dust for a given amount of work is disproportionately greater when fresh grinding wires have to be constantly employed than if only a single pin point is used to do the grinding.

In order to deal with these difficulties, Messrs. Werths & Co., of London, England, have introduced a machine for grinding and polishing diamond dies by means of an improved movement which, it is claimed, overcomes the disadvantages of the preceding methods. Its fundamental feature consists of having the point of the grinding tool employed, mounted in the perforation of the draw-stone which rotates on a vertical axis, while the pin rocks to and fro in a known manner, slowly and uniformly about its vertical position or about the axis of rotation of the draw-stone, up to a given position of inclination to both sides or only to one side. The tool used is an ordinary slim pointed steel pin. This pin, moving without any compulsory guide under the action of its own weight, merely slips into the hole so far that the pin in passing its central position rests freely and without impediment on the walls of the draw-hole. Thus the pin point, in its movement toward the inclined position, may be simultaneously drawn further out of the draw-block hole commencing at a given position of inclination in rocking back the pin. By this means, as will be seen from the illustrations showing the pin upright and in its oscillating position, in the vertical position the point of the pin, which would otherwise again grind the form of the hole exactly as it was at the commencement of the grinding operations, encounters the perforation at its narrowest place where it is non-circular. This is necessary in order to make holes which are non-circular again circular. By the deflection of the pin and the simultaneous drawing out of the pin point from the perforation, the advantage is obtained, apart from an oblique position corresponding to the conical form of the perforation of the stone, of the pin point not being too sharply bent over so as to press away or break the revolving stone which is only attached by means of wax. At the same time, the pin is so bent at the entrance end in the drawing motion, that the hole is formed somewhat curved.

The novelty and essential feature of the Poppe method here described, consists more particularly of the arrangement by which the grinding pin—under all phases of its grinding operation so long as it is not withdrawn—rests against the walls of the perforation of the stone by its own weight, so that non-circular holes must be ground circular. Also, that when the pin scrapes along the walls of the hole, that is to say, when it rises and falls, the polishing material is always again conveyed to the place of grinding which allows of a very economical consumption of the expensive diamond dust. The correct form of the perforation, namely the gradual tapering of the hole by means of slightly curved walls of the hole on one side and a suitably small enlargement of the outlet of the hole on the other side, is properly ground by the special action of the polishing pin so that the draw-stone thus treated is characterized by smooth and even drawing and greater durability. No compulsory guidance of the polishing needle takes place except on the periods of its withdrawal, so that perfect grinding is assured even if the diamond is not centrally mounted exactly to a hair's breadth and the stone-holder is not pushed away from the table. By the free running guidance of the pin, its wear is retarded and the pins may be placed in and out of action in the hole without stopping the machine or impeding the operation of other pins. The machine occupies the very small space of 26 inches by 38 inches, and requires about one-sixth horsepower to drive it. The smallest and largest calibers may be mounted simultaneously side by side, the needle being chosen fine or heavier according to the size of the hole, the weights on the pin-holder being adjusted accordingly. The grinding action is automatic and hence the draw-holes are not spoiled for want of attention or experience, and it is claimed that one workman can easily attend to two or three such machines, polishing twenty to thirty stones simultaneously. The use of these machines has been adopted to a considerable extent in England, Germany, France, Austria, etc., and will probably receive favorable attention where their special features become known.



An Improved Method of polishing Diamond Dies used for Wire Drawing

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

140-148 LAFAYETTE STREET, NEW YORK CITY

51-52, CHANCERY LANE, LONDON, ENGLAND

Cable address, Machinery New York

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

DECEMBER, 1914

NET CIRCULATION FOR NOVEMBER, 1914, 25,106 COPIES

MERCHANDIZING IDEAS

The value of a technical journal like MACHINERY lies chiefly in the force with which it appeals to its special class of readers. Readers of MACHINERY are practical men in the mechanical industries, from the proprietor and superintendent down. These men read the periodical to become informed on the latest developments in shop practice and the new equipment for machine shops. To effectively appeal to these men and to serve them efficiently, it is necessary to have the co-operation of the brightest minds in the field—the cooperation which means writing articles based on personal experience. It is not easy to get such cooperation.

Technical or trade journals of large circulation that are so fortunate as to have among their subscribers men willing to write out of their valuable practical experiences are in an advantageous position, and cooperation of this sort can be developed only through conducting a journal along right lines. It must be practically helpful—not helpful in a patronizing sense, but in the true sense. It must give the definite, useful, shop and technical information which such a journal is read for. The reading matter must be carefully selected and presented in a manner that is attractive, clear and forceful. That means careful, conscientious editorial work. A paper conducted on such lines has no space for puffs or write-ups offered for advertising considerations. The editorial and advertising departments must be absolutely separate and independent, serving distinct purposes as they do, but not so estranged that each has no idea of what the other is doing. An advertising department ignorant of developments in the mechanical world as recorded in the reading pages is not in the best position to serve its clients. And an editor who neglects to read the advertising in his own and other technical journals is likely to grow out of touch with the commercial side of the business, which he cannot afford to do.

It would be absurd to present general articles on economics in a trade journal devoted to tanning, but some phases of economics interest the tanner as much as the banker. Here is where a difficulty often lies in judging material offered for publication in a strictly technical or class journal. Articles in general, besides being of special interest to the class or industry represented, should be simple, straightforward and plain, but not so simple as to belong to the kindergarten class. Between the kindergarten class and the profound type of article that no one understands except perhaps the writer, is a wide range that can be worked profitably by those who aspire to reach others in their respective trades.

* * *

WASTE IN EMPLOYING LABOR

The address by Magnus W. Alexander of the General Electric Co. at the annual convention of the National Machine Tool Builders' Association was a revelation of enormous wastes in the employment of labor. The magnitude of these wastes is appalling. Mr. Alexander dealt only with the manufacturers' losses, but undoubtedly the losses of employes due to being misfits in positions are much greater. Notwithstanding the practical impossibility of obtaining exact figures on the cost of employing labor, Mr. Alexander endeavored to make an investigation that would throw some light on average conditions. He divided employes into five classes and segregated the cost of employing each class. This ranged approximately from $8.50 to $65 each in the General Electric plants. These costs included the clerical cost of hiring, the estimated instruction cost, the estimated losses of production, and damage to machinery and tools.

When these losses per individual are multiplied by thousands, the aggregate is enormous. In one period the General Electric Co. hired over 42,000 persons, and out of that number secured a permanent addition to its force of only 7000. When the magnitude of these figures is considered, the extent of the losses throughout the country due to indiscriminate hiring and firing of help can be better appreciated. No doubt the losses are to some extent unavoidable, but more care on the part of those who hire would eliminate a large percentage of these.

The Norton Co., Worcester, Mass., has attacked the problem intelligently with the view of fitting the round pegs in the round holes and the square pegs in the square holes. The characteristics of each individual applying for employment are carefully studied, and if need be he is given a preliminary training of short duration before being turned over to the foreman in whose department he is to be employed. If greater care in selection were exercised and if foremen realized the cost of firing a man for some petty breach of discipline, the losses to employers and to employes could be reduced materially.

* * *

REFORM IN WORKING DRAWINGS

A mechanical drawing may or may not be an artistic piece of work, but if it conveys the right message to the men in the shop its mission is accomplished. Unfortunately, the practice of making mechanical drawings has never been standardized and there is no agreement on the so-called "conventions" used by draftsmen to save time and space. The result is that many mistakes are made in reading drawings.

Mr. Fish, whose paper was read before the recent convention of the National Machine Tool Builders' Association, pointed out some of the common mistakes made in drawings and advocated the more liberal use of the English language wherever mistakes were likely to occur. There is no agreement on the common conventions, and every draftsman is free to add conventions of his own. This is a great mistake. A drawing should tell its own story without the aid of an interpreter. If it needs an interpreter it is seriously lacking.

The situation seems to be one that in the first place demands standardization of practice in the making of mechanical drawings and uniformity in conventions, if they are to be used. The use of conventions in general, however, is to be deprecated for the reason that no matter how well they are commonly understood by the drafting fraternity, the conditions in modern shops will always lead to mistakes. Many men are employed in machine shops who have had no mechanical training and consequently have never studied mechanical drawing. A laborer put to work on a boring mill may be required to read a mechanical drawing, but to such an employe common conventions are Greek, and he must have the aid of the foreman or someone else to explain them. Legends in English are generally understandable and should therefore be employed in preference.

STRENGTH OF MATERIALS

In the design of machinery, nothing is more important than to be able to determine the stresses to which a machine member is subjected in order that it may be given adequate strength for the purpose intended. This is especially true in the case of machinery in which the failure of the component parts might cause danger to life and serious damage to property. As every student of the theory of the strength of materials knows, accurate calculations can be made for the strength of many of the parts entering into machine design. But there are also many parts for which calculations are impossible, or for which they would be so involved and uncertain that the sum of experiences is the only guide upon which the machine designer can depend.

Whenever calculations can be conveniently made, they should be carried out; but successful designs and the results of practical experience should be compared with the calculated results wherever possible, as in this way theory and practice can be made to supplement each other. There are many practical conditions, especially when such metals as cast iron are dealt with, that require consideration in addition to mere calculated strength; in all cases where a machine part is exposed to excessive wear this factor must be considered also.

Sometimes wear may be such an important factor that the designer must base his calculations for strength, not on the dimensions of the parts when new, but when they have been in use for a period of time. This applies particularly in the case of gear teeth.

There are no hard-and-fast rules to follow for many problems relating to strength of materials, but judgment and experience (and the "factor of safety," sometimes called the "factor of ignorance") will always prove valuable aids to the designer, no matter how well versed he may be in the general theory of the strength of materials.

* * *

IMPORTANCE OF ACCURATE SCREW THREADS

Hundreds of patents have been taken out on nut-locking devices, and thousands of dollars have been spent in promoting them—with more or less profitable return. Nut-locks are absolutely necessary in some places, but in many others they cannot be used because of trappiness, cost and inconvenience of application. Thousands of machinery parts are lost or ruined every day because nuts and set-screws loosen and work out. House hardware falls to pieces for the same reason, and everyone having experience can recollect cases where loose screws have caused loss, inconvenience and sometimes danger to life and limb.

This common trouble brings us to a consideration of the importance of accurate and close-fitting screw threads. As stated above, nut-locks are often positive necessities, especially on railroad tracks, motor cars and other screw-connected parts in which vibration is excessive and appreciable turning moments are developed by the vibration. The less the tolerance or space between nut and screw the less effective is vibration in loosening them, of course, but the best screw fits are not proof against rapid and long-continued vibratory action. On a great many machine parts, however, well-fitted screws and nuts once tightened will remain indefinitely locked by friction alone. The reason that so many screws needlessly work loose is because of inaccuracy of fitting. This was recognized years ago by the leading typewriter manufacturers, and action was taken to correct the evil. It is not easy to make a machine screw that will fit a tapped hole so closely as not to work loose in service, and that still can be screwed in readily when assembling. Such conditions can be reached only by refinements of tap and die making and methods of manufacture developed under the direction of highly skilled and competent men. The result, however, is well worth the cost, and too much care cannot be taken by machinery builders to secure good fitting screw threads in all machinery parts. They are the evidence of good work—work that saves customers an untold amount of worry and inconvenience, and losses of all sorts that now are common because of ill-fitting screws.

ORGANIZING FOR SAFETY

BY A. J. DALY*

The wonderful change effected by the safety organizations of the large industrial corporations who were pioneers in welfare work, has been one of the bright spots in the industrial progress of the last decade. In practically all plants where safety work has been organized, there have been lower percentages of injury, lower casualty costs and wonderful improvement of the *esprit de corps* of the employes. The results obtained by their organization are now being duplicated by other companies, and the following contains some ideas on starting the work.

In starting or organizing the safety work in a plant where little or nothing has been done, the management is always confronted with the problem of deciding which one of several methods it shall use. The company has the choice of employing a safety engineer and putting him in charge of the work; of organizing safety committees from among its workmen, and being guided by their recommendations; or of placing the work under one of the existing departments and allowing it to be carried along with the usual work. Generally the choice of methods lies between the first two mentioned, namely a safety inspector or a safety committee. The practice of placing safety work under the charge of the repair, millwright or mechanical departments has several serious disadvantages. The duties of these departments are generally so varied that the foreman or master-mechanic is busy at all times with his routine work, so that safety work would be slighted or considered as a side line—a thing to be avoided. Then, again, the men in charge of these departments usually view things from a production standpoint, and therefore do not always see the necessity of safety appliances.

As stated before, the choice is usually between a safety engineer and a committee picked from workmen of the plant. In making this decision, I believe the management should be guided by the following considerations:

1. The condition of the plant; is it hazardous; is it plainly apparent that much work will have to be done?

2. The speed with which the work is to be completed; is it the intention to do a moderate amount each month, or is the work to be rushed to completion?

3. The attitude of the employes toward the safety movement and toward the company in general.

The following detailed discussion of each point will show the reasons for this belief. If a plant is in poor shape (from a safety standpoint) and it is obvious that a great deal of work must be done in the line of gear guards, railing and safety equipment, it is by far the better plan to place the work in charge of a competent safety engineer. If one man is in charge he can be in closer touch with the management and can plan the work so as to take up the more dangerous places first. This is often difficult when working with a committee taken from various parts of the work. Each man will honestly feel that the danger point or unguarded machine in his own department is the more hazardous, and will be a little disappointed if the work is sidetracked for another job.

Then, again, a committee of workmen loses interest and enthusiasm if their recommendations are not carried out quickly. They soon begin to feel that they are figure heads and that the officials in charge do not care for their suggestions. With one man in charge the case is different, as he can understand the difficulties and limitations, and can work accordingly. In every plant there are bound to be limitations as to money expended, and it very often happens that one large job, such as guarding the cranes or placing walks over lineshafts may take the entire safety appropriation for several months. In a case like that, if a workman should make a suggestion of minor importance and find that it was delayed three to six months, he would be likely to lose interest. The explaining of the plan of work does not seem to satisfy him, as he sees only his own suggestion and wishes it completed. Another point concerning recommendations made by employes and delayed because of more important work, is the fact that if an accident occurs at a point where an employe recommended a guard an excessive amount of criticism

* Safety Inspector, American Steel Foundries, Sharon, Pa.

is heaped on the management, and the cry of "I told you so" is heard. Unless the management is in a position to install all worthy suggestions of employes almost immediately, I believe it is better that no suggestions be asked for.

When the work has advanced to the point that suggestions can be given reasonably prompt attention, the value of a safety committee becomes apparent. A workman imbued with the safety spirit can uncover more dangerous conditions than any safety inspector could hope to find, and by working a committee in conjunction with a safety inspector, the dangerous points will soon be located. Probably 75 per cent of the suggestions would come from the members of the safety committee. In plants where most of the workmen are satisfied and men of long service, the committee system is particularly effective, as the men are naturally interested in their work and are quick to note the attitude of the management, and hence respond at once. The real and greatest value of the committee comes in the education of employes and prevention of unsafe practices. If a committee works faithfully along this line, it can accomplish more than a safety inspector, for the reason that the members are on the job all the time, and see everything, while one man cannot be everywhere. Hence, the following conclusions are drawn: In a case where a great deal of work is to be done over a long period of time, use a safety inspector; where the work is to be finished quickly and the attitude of the employes toward the company is good, use a committee; in case of doubt, use a safety inspector.

* * *

LOCATING THE CRITICAL RANGE WITH THE BRINELL BALL TESTER

BY J. GERRISH AYERS JR.*

The location of the upper critical points in steel calls for quite an elaborate outfit and the manipulations must be performed with extreme care. The foot of the range, however, can be determined quite readily by a single thermo-couple, as the quantities of heat dealt with are relatively large compared with the amount absorbed or evolved at the upper critical points, except in the very low carbon steels. In the higher carbon steels where the eutectic point or $Ac_{3\text{-}2\text{-}1}$ (as the case may be) is the correct hardening temperature the determination can easily be effected, but the upper points Ac_3 and $Ac_{3\text{-}2}$ of the lower carbon steels are generally determined

BRINELL HARDNESS NUMBERS AT VARIOUS QUENCHING TEMPERATURES

Specimen Number	Brinell Hardness Number	Quenching Temperature in Degrees F	Specimen Number	Brinell Hardness Number	Quenching Temperature in Degrees F
1	187	1300	18	600	1470
2	187	1310	19	600	1480
3	187	1320	20	600	1490
4	187	1330	21	600	1500
5	187	1340	22	600	1510
6	187	1350	23	600	1520
7	340	1360	24	600	1530
8	387	1370	25	600	1540
9	460	1380	26	600	1550
10	512	1390	27	600	1560
11	555	1400	28	600	1570
12	578	1410	29	600	1580
13	600	1420	30	600	1590
14	600	1430	31	600	1600
15	600	1440	32	600	1610
16	600	1450	33	600	1620
17	600	1460	..	...	....

Machinery

by the use of a neutral body and a recording device such as is embodied in the Saladin outfits. In these methods the points are located by the sudden absorptions or evolutions of heat involved in the transformations taking place at the critical temperature. In the method here described the points are detected by a far more pronounced phenomenon, namely, the difference in the hardness resulting from the changes in the micro-structure of the metal quenched at different temperatures within and without the critical range. In consequence, this method does not require a particularly elaborate or delicate equipment and gives results which may be directly applied to commercial hardening without the interpretation of heating or cooling curves.

The apparatus used was a Heraeus electric furnace equipped with a Le Chatelier pyrometer for heating the specimens to the desired temperature, and an "Alpha" Brinell ball tester for accurately determining the hardness of the quenched specimens. Thirty-three specimens about 12 millimeters by 6 millimeters by 50 millimeters in size were cut from the same piece of steel and suitably machined for

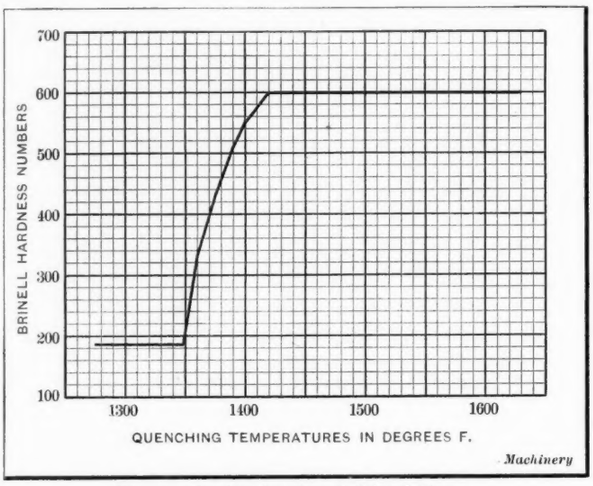

Diagram showing Location of Critical Range

the Brinell hardness test. Starting at 1300 degrees F., a piece was heated and quenched in water. The same procedure was followed with successive pieces up to 1620 degrees F., in 10-degree increments. Each piece was in the furnace a given time and all were allowed to become thoroughly saturated with heat at their respective temperatures. Every reasonable precaution was taken to keep the temperature of the quenching medium constant and to make all other conditions of the test as nearly uniform as possible, so that the hardening temperature would be the only varying factor. After the pieces were hardened they were given a final polishing to remove the scale and then subjected to the Brinell hardness test, with a standard load of 3000 kilograms and a ball 10 millimeters in diameter. The accompanying table gives the Brinell hardness numbers for the various temperatures at which the pieces were quenched. The diagram shows a curve obtained by plotting hardness as ordinates and quenching temperatures as abscissae, and depicts graphically the location of the critical range.

From this data we conclude that no change affecting the hardness of the steel has occurred below about 1350 degrees F. but at 1360 F. we cross the foot of the critical range, *i.e.*, the point Ac_1 where the pearlite goes into the solid solution producing a sudden increase in the hardness of the steel. At 1370 degrees F. some ferrite has entered into the solid solution and the steel becomes still harder. This change progresses until 1420 degrees F. has been reached when the balance of the ferrite is dissolved and the maximum practical hardness of the steel is obtained—600 Brinell hardness in this case. Higher temperatures up to 1620 degrees F. show no increase in the hardness of the steel, but the fractures indicate the increasing temperature by their increasing coarseness. Consequently we have ascertained that about 1420 degrees F. is the top of the critical range and the proper hardening temperature for the steel in question, although in practice it is advisable to heat a little higher to allow for any delay in manipulation that might possibly lower the temperature.

* * *

In their efforts to produce an aluminum alloy which would not be appreciably heavier than aluminum, but would possess a much greater tensile strength, German chemists have succeeded in making an alloy which has a tensile strength three times that of aluminum and which is composed of 1 per cent of tungsten and 9 per cent of cobalt or 0.8 per cent molybdenum and from 9 to 10 per cent of cobalt, the remainder being aluminum.

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DATA ON SURFACE AND CYLINDRICAL GRINDING*

OPERATING CONDITIONS AND RATES OF PRODUCTION FOR TYPICAL OPERATIONS

BY ROSS HOLMES†

IN connection with the detailed investigation of crankshaft grinding as summarized in the August number of MACHINERY, data were taken on the other general classes of grinding and the following detailed classes were chosen as typical. In machining the parts of an automobile engine, the grinder puts the finishing touches on nearly all the moving surfaces, although in many cases they are previously rough-turned or bored to reduce the amount of metal to be removed.

Pistons, Piston Pins and Piston Rings

For example, pistons are roughed out on a Foote-Burt piston machine which reduces them to rough size, faces off the end and machines the ring-grooves all in the same operation. Then a plate is fitted in the open end to provide a center and the work is placed in a 12 by 32 Norton grinder. The grinding wheel is a 24 L Norton, 18 by 2 inch, running at 1500 revolutions per minute or a surface speed of approximately 7000 feet per minute. The work is driven by a projection on the plate which engages a projecting bolt held in the spindle. Its speed is adjusted to about 90 feet per minute while the traverse motion covers the length of the piston and returns in 30 seconds. Three times across the piston finishes it. From 0.030 to 0.040 inch is left on for grinding, and on the first cut across, the wheel is held right up to the finished dimension. The work gives enough to leave plenty for finishing, which is accomplished by one complete traverse motion without shifting the wheel. In taking the roughing cut, the wheel is advanced by hand and this takes an average of 27 seconds. Then 20 seconds are spent in micrometer gaging and changing pieces in the machine. Combining these two times with the finishing cut time as determined by traverse, *i.e.*, 30 seconds, gives one minute and 17 seconds as the production time. However, such is the variation in the castings and the closeness of the allowable limit of 0.001 inch either way, that 215 pistons represent a good day's work.

The piston pin is ground on a 10 by 36 Norton grinder using

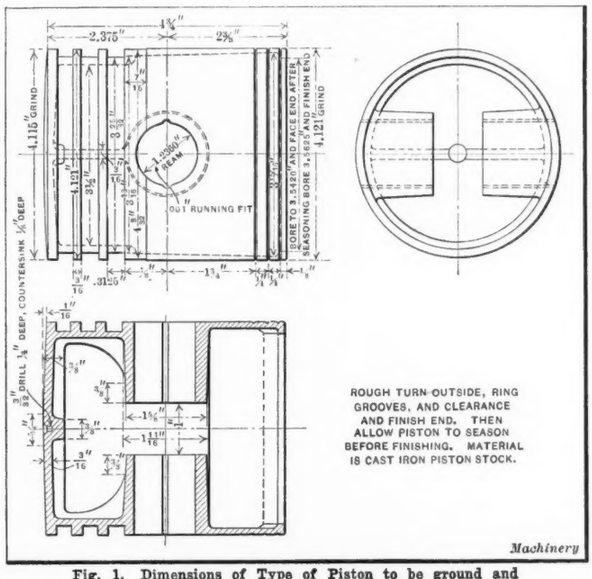

Fig. 1. Dimensions of Type of Piston to be ground and Instructions for Machining Operations

a 24 M Norton wheel. This wheel is 2 inches wide by 18 inches in diameter, and runs at 1200 revolutions per minute or a surface speed of 5660 feet per minute. When the wheel wears down to 16 inches in diameter, the belt is shifted to the smaller pulley giving a speed of 1400 revolutions or 5870 feet per minute. Experiments made with 24 L wheels showed that they were too hard and checked the work, while 24 N wheels merely wore away rapidly without giving a good finish. The work revolved at 156 revolutions per minute or 50.5 feet per minute, at which speed a pin was finished in 2 minutes and 27 seconds, which represents the complete time inclusive of

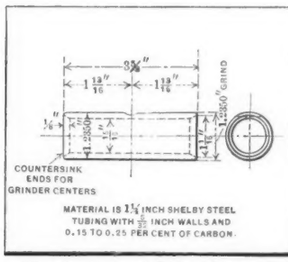

Fig. 2. Type of Piston Pin to be ground

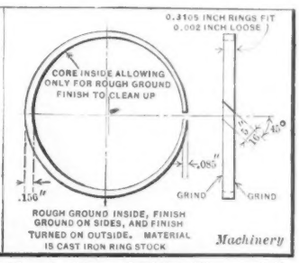
0.3105 INCH RINGS FIT 0.002 INCH LOOSE
CORE INSIDE ALLOWING ONLY FOR ROUGH GROUND FINISH TO CLEAN UP
.085"
.156"
GRIND
GRIND
45°
ROUGH GROUND INSIDE, FINISH GROUND ON SIDES, AND FINISH TURNED ON OUTSIDE. MATERIAL IS CAST IRON RING STOCK
Machinery

Fig. 3. Type of Piston Ring used in Piston shown in Fig. 1

changing the work and adjusting the machine, plus an allowance for dressing the wheel. This piece is made from a 3⅝-inch length of 1¼-inch Shelby steel tubing ground to 1.235 inch. This leaves about 0.0175 inch of stock to remove, as the tubing comes a bit over size. The steel in the tubing contains from 15 to 25 points of carbon, and is carbonized to a depth of 0.03 inch and then hardened before grinding. The speed of the traverse depends entirely upon the hardness of each individual pin and cannot be determined in advance.

Piston rings are ground after being rough-turned and are held to an accurate size by means of a magnetic chuck on a Heald ring grinder equipped with a 9 by ⅝ inch wheel. A 24 L Norton vitrified wheel is used to rough off 0.030 inch, leaving 0.005 inch for the finishing operation which is done with a 40 J carborundum wheel. The work is rotated to give a surface speed of 160 feet per minute and the grinder wheel runs at 2100 revolutions per minute or a surface speed of about 5000 feet per minute. At these speeds about 150 rings are the average daily run on either the roughing or finishing operations.

Grinding Operations on the Live Shaft

The live shaft has four surfaces to be finished on the grinder—the taper upon which the wheel fits, the main bearing, the oil retainer fit for the differential case and the differential bearing. The taper is ground in a 12 by 42 Landis grinder using an 18 by 3 inch 24 M wheel rotating at 1500 revolutions per minute or a surface speed of about 7000 feet per minute. This is somewhat faster than would ordinarily be recommended for this wheel, but the speed is necessary to get the required finish. The work speed is quite slow, being from 30 to 40 feet per minute, depending upon what point of the taper is measured. The tapered end is hardened to a scleroscope test of 75. This is too hard for a grade L wheel; otherwise, if it could be used, the finish could be obtained at a lower speed than 7000 feet per minute. A ring gage is used and the allowable variation is 1/64 inch sideways on the taper. This corresponds to a variation of about 0.002 inch. Taking off 0.035 inch of stock on a straight cut, the cutting time is 35 seconds and the total time 46 seconds. After grinding sixteen pieces, it is necessary to dress the wheel, which takes from one to two minutes. Considering all adjustments and variations in stock, the standard output for this operation is 350 per day of 9 hours.

The main bearing is ground on the same machine running at the same speed. Owing to variations in the width of this bearing, it is sometimes possible to feed straight in, while on other pieces the traverse must be used. Where the first type of feed is possible the time is 35 seconds, against 42 seconds with the traverse. The No. 64 work speed of this machine is used on the traverse while the actual cutting time is 21 seconds. This bearing is ground to an accuracy of 0.001 inch.

The oil retainer fit does not require such a close limit, within 0.005 inch being sufficiently accurate. The same type

* For articles on rates of production on the grinding machine and allied subjects in MACHINERY, see also "Crankshaft Grinding," by Ross Holmes, published in August, 1914, and other articles there referred to.

† Address: Care of Reo Motor Car Co., Lansing, Mich.

of machine is employed equipped with the same size of wheel and driven at the same speed, except that a 24 L wheel is used. The work speed is 40 feet per minute. About 0.05 inch of stock is removed in 46 seconds. The total time, including gaging and setting up, is 83 seconds. After grinding eleven shafts, it is necessary to dress the wheel. This takes 1½ minute or about 8 seconds per shaft, which brings the total production time to 91 seconds. However, the output of the machine averages about 180 shafts per day or one every 3 minutes. This is due to changing wheels and changing jobs.

The bearings for the differential gear have to be ground

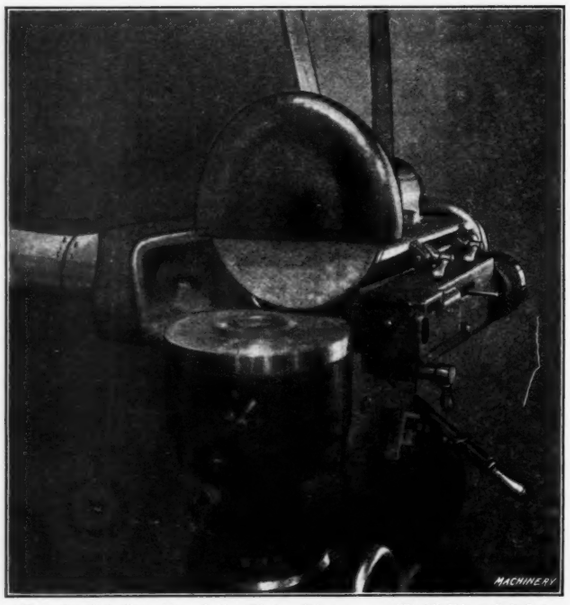

Fig. 4. Grinding one of the Piston Rings on a Heald Ring Grinder

to an even closer limit, 0.005 inch being the specified limit with 0.028 inch of metal to remove. The cutting time is 30 seconds using a straight-in feed and 50 seconds covers the whole operation, including changing, gaging and grinding.

Surface Grinding Between Two Keys

Another variety of work, where the surface to be ground lies between two keys, is represented by the sliding gear shaft. This is cut off from the bar stock and has the end bearings turned, after which the work goes to a Barber-Colman miller which uses a forming cutter and roughs out the sliding keyways, leaving the splines. The grinding is done on a Bath No. 20 multiple key shaft grinder, using a 46 M Norton 3⅛ by 1 inch wheel. This wheel is hollowed out to the shape of the shaft and the work is moved longitudinally beneath it. The wheel runs at 2160 revolutions per minute or approximately 1700 feet per minute. This machine is furnished with a four-way dividing head and an index attachment which centers the sliding way with the wheel when adjusting the grinder dog. The roughing operation leaves 0.0045 inch of metal for grinding and this is usually removed in three rotations of the shaft. The wheel is advanced to 0.001 inch of the finish size and the work rotated twice or eight traverse cuts. Each traverse cut and return takes 10 seconds for the 8-inch travel. The wheel is now set up a trifle and the next two sides traversed, after which the micrometers are applied and the final two sides ground accordingly. The actual cutting time varies from 220 to 225 seconds, while the whole operation takes an average of 3¾ minutes. Dressing the wheel takes 40 seconds and causes the next shaft to take an undue length of time through resetting the stop. The diamond is held in the end of a bar which has a radial motion relative to the table, producing a perfect concave surface in the wheel. Two other diamonds face off the side bevels, and thus dressing the wheel becomes a short operation. Each wheel is good for about 300 shafts and then 30 to 40 minutes are required to change wheels and dress the new one. A production of 13 shafts per hour represents a very good average on this work.

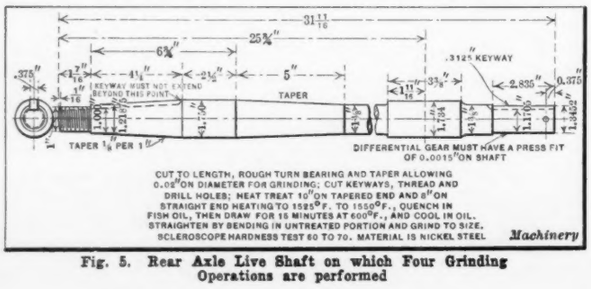
.312" KEYWAY
TAPER
TAPER 1/8" PER 1"
DIFFERENTIAL GEAR MUST HAVE A PRESS FIT OF 0.0015" ON SHAFT
CUT TO LENGTH, ROUGH TURN BEARING AND TAPER ALLOWING 0.08" ON DIAMETER FOR GRINDING; CUT KEYWAYS, THREAD AND DRILL HOLES; HEAT TREAT 10" ON TAPERED END AND 8" ON STRAIGHT END HEATING TO 1525° F. TO 1550° F., QUENCH IN FISH OIL, THEN DRAW FOR 15 MINUTES AT 600° F., AND COOL IN OIL. STRAIGHTEN BY BENDING IN UNTREATED PORTION AND GRIND TO SIZE. SCLEROSCOPE HARDNESS TEST 60 TO 70. MATERIAL IS NICKEL STEEL
Machinery

Fig. 5. Rear Axle Live Shaft on which Four Grinding Operations are performed

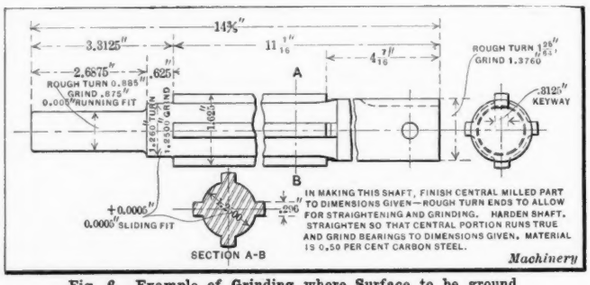
ROUGH TURN 1.385" GRIND 1.3760
.3125" KEYWAY
A
B
IN MAKING THIS SHAFT, FINISH CENTRAL MILLED PART TO DIMENSIONS GIVEN—ROUGH TURN ENDS TO ALLOW FOR STRAIGHTENING AND GRINDING. HARDEN SHAFT. STRAIGHTEN SO THAT CENTRAL PORTION RUNS TRUE AND GRIND BEARINGS TO DIMENSIONS GIVEN. MATERIAL IS 0.50 PER CENT CARBON STEEL.
SECTION A-B
Machinery

Fig. 6. Example of Grinding where Surface to be ground lies between two Keys

Internal Grinding

Grinding internal surfaces such as sliding gears for the transmission is done on a No. 70 Heald machine using three 46 K Norton wheels placed side by side, each wheel being 1¼ by ⅜ inch in size. These wheels run at about 8500 revolutions per minute or a surface speed of about 2800 feet per minute. At this speed they remove 0.007 inch from the inside intermediate sliding gear in a few seconds over a minute, while the whole production time is about 100 seconds.

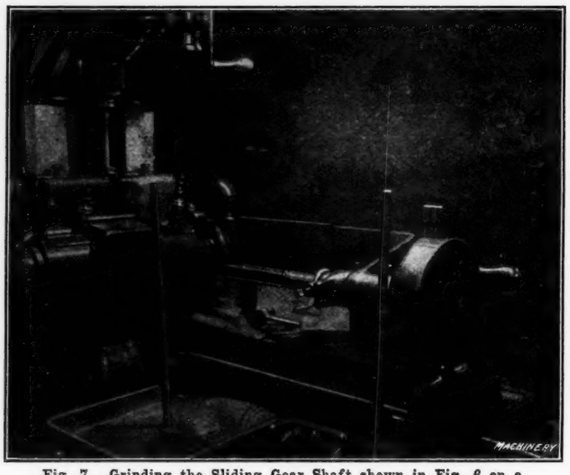

Fig. 7. Grinding the Sliding Gear Shaft shown in Fig. 6 on a No. 20 Bath Key Shaft Grinder

With the same set-up, 0.010 inch of stock is ground from the low speed gear in about 1½ minute, and the whole production time including gaging and changing stock is 2¼ minutes. Two plug gages are used, one being 0.0005 inch under size. This allows it to slip through the front face of the gear and test the other side and aids in making the hole the same size at both ends. These gears are held in a three-piece expanding collet chuck which is carefully cleaned each time with an air blast to be sure of the perfect centering of the gear. Owing to changing wheels and also to the necessity of adjusting the machine, inasmuch as the same man works on a variety of gears each day, 160 gears constitute a full day's work.

Sleeves are ground on a similar machine using a 36 J wheel 3 by ⅝ inch in size. This wheel running at 7500 revolutions per minute gives a surface speed of 5900 feet per minute. The traverse is set to cover the sleeve in 5 seconds each way. The amount of stock removed is 0.018 inch, with a limit of 0.001 inch either way for accuracy. On the first cut the feed is by hand to smooth up unevenness in the stock. After that the finish is produced by the traverse. The production time for this size of sleeve is 2½ minutes.

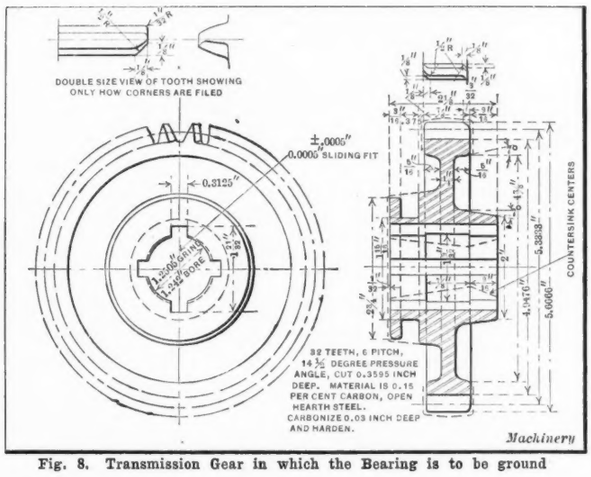
DOUBLE SIZE VIEW OF TOOTH SHOWING ONLY HOW CORNERS ARE FILED
±.0005"
0.0000" SLIDING FIT
0.3125"
1.2500" GRIND
1.2490" BORE
COUNTERSINK CENTERS
5.3838"
5.6066"
4.0476"
32 TEETH, 6 PITCH, 14½ DEGREE PRESSURE ANGLE, CUT 0.3595 INCH DEEP. MATERIAL IS 0.15 PER CENT CARBON, OPEN HEARTH STEEL. CARBONIZE 0.03 INCH DEEP AND HARDEN.
Machinery

Fig. 8. Transmission Gear in which the Bearing is to be ground

Cylinder grinding presents quite a different class of work. No. 10 Brown & Sharpe grinders are used with a 303 F carborundum wheel 3½ inches in diameter by ¾ inch wide. This wheel runs at 3900 revolutions per minute, which corresponds to a surface speed of 3580 feet per minute. The recommended speed for this wheel is from 5000 to 6000 feet per minute, but such practice ruins the bearings of the machine in a short time and causes the wheel to glaze over, heat up and ruin the work. The present speed was determined by gradually slowing down from the recommended speed to the present one which produces the greatest quantity of acceptable work with the greatest economy. The wheel is held on an eccentrically

Fig. 9. Battery of No. 70 Heald Grinders for grinding Gears shown in Fig. 8

placed spindle and it is by means of this eccentricity that the depth of cut is determined. However, there is no scale or gage to show how much the spindle is off center and consequently the setting requires considerable skill, since it is only by the amount of spark and sound that the depth of cut can be judged. The spindle eccentric or head rotates at a speed of 104 revolutions per minute.

First, the cylinder is placed in the jig and lined up. This is done by allowing the wheel to touch the casting lightly, and then it can be seen which way to shift it in order to remove an equal amount of stock on all sides. This shifting is done by adjusting screws on the top, bottom and sides of the gib as explained in the detailed article by Douglas T. Hamilton entitled "Production Tools for Reo Engine Cylinders," published in the September number of MACHINERY. Once lined up the wheel is set in for the full depth of the roughing cut—usually about 0.006 inch—which is taken off in one traverse and return. The cylinder springs enough so that about two-thirds of this amount or 0.004 inch is removed on the first travel and the remaining 0.002 inch is left for the return travel. An average of 110 seconds is needed for the traverse to cover the length of the cylinder once. This is the slowest traverse on the machine. After this cut, the cylinder is micrometer gaged and the finish cut made accordingly. Reo cylinders are ground to an accuracy of 0.001 inch either way or a variation of 0.0015 inch out of round. Since these cylinders are cast in pairs, the jig must now be shifted to the other cylinder end, relined up and the grinding done on it. On these machines the best observed time was 14 minutes 56 seconds. Including making all adjustments, dressing the wheel, and allowing for bad castings, this would mean from 32 to 35 cylinders per day ground to these limits. However, in the actual method used, two machines are operated by one man, in this way utilizing his time to the best advantage. He sets up one job during cuts on the other, finishing from 45 to 50 cylinders daily with an average speed of about 23½ minutes each.

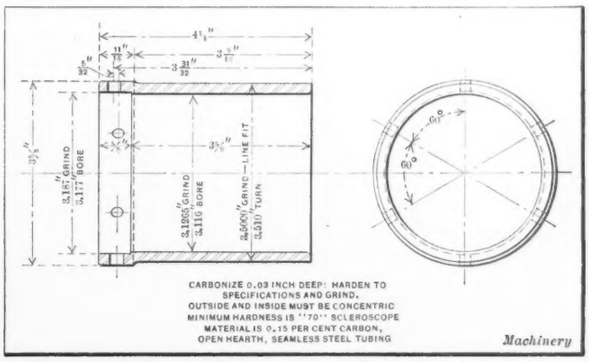

Fig. 10. The Type of Sleeve for which Grinding Data is presented

The tabular summary presented herewith gives a comparison of the times and amount of work, and these form the basis for the standards in miscellaneous grinding work. In the calculations no account is taken of minor details such as the cross-bored hole in the piston, for the piston would take as long to machine if this hole were solid metal and consequently it is so considered. The apparent variation in the grinding time per square inch or per cubic inch is caused either by a variation in the hardness of the stock or by a difference in the allowable limits of variation. The timing of the piston ring presented some difficulty, inasmuch as stock left on by the roughing machine had to be removed by the finisher. In other words, speeding up one operation resulted in adding to the time on the other operation. The most efficient work seems to result from an equal division of time between the roughing and finishing operations.

GRINDING STANDARDS ON CLASSES OF WORK UNDER CONSIDERATION

Part	Type of Grinding	Operation	Time		Area Ground, Square Inches	Volume Removed Cubic Inches	Type of Wheel
			Minutes	Seconds			
Piston	External surface		1	17	36.60	1.280	24 L Norton
Piston pin	External surface		2	27	14.08	0.246	24 M Norton
Piston ring	Sides of ring	Rough	3	36	1.571	0.047	24 L Norton vitrified for roughing
		Finish	3	36	1.571	0.0079	40 J carborundum for finishing
Live shaft	External surface	Taper		46	18.4	0.644	24 M Norton
		Main bearing		35	18.40	0.460	24 M Norton
		Oil retainer	1	31	13.75	0.688	24 L Norton
		Differential bearing		50	11.97	0.335	24 L Norton
Sliding gear shaft	Longitudinal		3	45	18.6	0.0836	46 M Norton
Sliding gear	Internal surface		1	40	8 35	0.0585	46 K Norton
Sleeve	Internal surface		2	30	30 65	0.552	36 J Norton
Cylinder	Internal surface		14	56	129.75	7.775	303 F carborundum

Machinery

SOLDERING AND BRAZING ALUMINUM

THE PRACTICAL PROBLEMS INVOLVED—SOLDERS AND FLUXES TO USE AND METHOD OF PROCEDURE

BY FOREMAN JOINTER

MUCH has been written in recent years about aluminum and its peculiar characteristics, but comparatively little has been published from the practical mechanic's point of view, although the metal is now used in a rapidly increasing number of industries, and has become an essential material in many of them. One of the cardinal arts in the manipulation of aluminum in the hands of the metal worker is the process of jointing. As the jointing of aluminum is popularly supposed to be a difficult process, the writer attempts in this article to deal with the various methods of jointing the metal, for modern requirements.

The art of jointing most commercial metals has been known and practiced for many centuries, but this is not the case with aluminum, as the metal is only in its infancy as compared with other common metals. Aluminum was obtained first in 1827, but at this period it consisted of a whitish-gray powder and it was not until 1845 that metallic pellets were obtained. In 1854 the metal was obtained in a state of almost perfect purity by St. Clair Deville. However, the jointing of aluminum was not done until 1855, and it is only within the last few years that satisfactory progress has been achieved.

Soft Soldering Aluminum

In the manipulation of aluminum it is essential that there should be simple and efficient methods of uniting two pieces of the metal. The process of soft soldering will, therefore, be considered first. There are, it is true, a great number of industrial applications where aluminum cannot be employed economically owing to a certain amount of difficulty encountered in soft soldering it effectively. Almost as soon as aluminum was produced commercially, it was discovered that the ordinary solders and fluxes could not be used with it, but in 1855 M. Christofle, a goldsmith of Paris, found that either pure tin or pure zinc would unite aluminum. In practice, however, the tin speedily disintegrates, while zinc by itself is brittle, and discolors badly. M. Hulot, therefore, tried an ingenious process of coating the surfaces with copper, and then soldering the coppered surfaces in the ordinary way, but after the lapse of a few months it was found that the copper stripped off very easily. Although innumerable attempts have been made to discover a satisfactory soft solder for aluminum, it would appear, that up to the present time, no practical, simple, and well tested process of soft soldering aluminum has yet been proved to be permanently successful, notwithstanding the large number of aluminum solders that are patented every year, each inventor naturally claiming superiority.

Composition of Aluminum Solders

The solders for aluminum consist chiefly of an alloy containing several metals in various proportions, *viz.*, aluminum, antimony, bismuth, cadmium, chromium, copper, lead, magnesium, phosphor-tin, silver, tin, vanadium, and zinc.

In the accompanying table various compositions of soft solders are given in tabulated form, which are but a selection from those that might have been given had space permitted.

It is frequently stated that joints made by these patent solders will stand the time test and retain their original strength after an indefinite exposure to atmosphere or other influences, but in a number of instances these guarantees have not been fulfilled. The writer has witnessed some recent demonstrations of patented solders for aluminum and has also used them and made tests for comparison, but it should be recognized that the merits of an aluminum solder cannot be judged without subjecting it to a duration test. Although remarkably strong joints were made by means of a blowpipe, the solders used melted at too high a temperature (about 608 degrees F.) to allow the ordinary soldering bit to be employed satisfactorily. These high-temperature solders greatly impede universal jointing of the metal and are, in the writer's opinion, largely responsible for many mechanics failing to obtain even a moderately good soldered joint; there are also many who still doubt the possibility of making a soldered joint in aluminum.

COMPOSITION OF SOLDERS

Letter	Tin	Aluminum	Zinc	Copper	Bismuth	Lead	Phosphor-Tin*	Silver	Antimony	Cadmium	Magnesium	Chromium	Vanadium
A	95.00	.....	.....	.....	5.00	.....	.....	.....	.....	.....	.....	.....	.....
B	78.50	2.00	19.00	.....	.....	.....	0.50	.....	.....	.....	.....	.....	.....
C	.....	66.70	.....	.....	.....	.....	.....	33.30	.....	.....	.....	.....	.....
D	20 00	70.00	.....	.....	.....	.....	.....	10.00	.....	.....	.....	.....	.....
E	97.00	.....	.....	.....	3.00	.....	.....	.....	.....	.....	.....	.....	.....
F	.....	6.00	89.50	4.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
G	71.25	2 25	26.00	.....	.....	.....	0.50	.....	.....	.....	.....	.....	.....
H	60.00	4.00	8.00	4 00	.....	12.00	.....	12.00	.....	.....	.....	.....	.....
I	37.50	.....	25.00	37.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
J	.....	8.00	92.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
K	30.00	.....	20.00	.....	.....	.....	.....	.....	.....	50.00	.....	.....	.....
L	80.00	2.25	17.00	.....	.....	.....	0.75	.....	.....	.....	.....	.....	.....
M	66.00	15.50	.....	.....	9.00	.....	.....	.....	7.00	.....	2.25	.....	0 25
N	15.50	2.50	78 25	.....	.....	2.50	1.25	.....	.....	.....	.....	.....	.....
O	.....	20 00	65 00	15.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
P	49 05	.....	20.31	1.15	.....	26 06	.....	.....	3.43	.....	.....	.....	.....
Q	30.00	70 00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R	.....	4.00	94.00	2.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
S	85 10	10.80	.....	.....	.....	.....	.....	.....	.....	1.35	2 75	.....	.....
T	60 00	.....	15.00	.....	5.00	10.00	.....	.....	5.00	.....	.....	5.00	.....
U	86.00	.....	.....	.....	14 00	.....	.....	.....	.....	.....	.....	.....	.....
V	98 00	1.00	.....	.....	1.00	.....	.....	.....	.....	.....	.....	.....	.....
W	20.00	70 00	.....	10.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
X	48.00	2 00	27.00	.....	.....	23 00	.....	.....	.....	.....	.....	.....	.....
Y	90 00	5.00	.....	.....	5.00	.....	.....	.....	.....	.....	.....	.....	.....
Z	84.95	.....	.....	.....	15.05	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

* Ten per cent Phosphorus

What is wanted is an effective and easily used solder (an alloy with the color of aluminum being preferable) which will make permanent joints in light and heavy work; a solder that can be used freely with the ordinary soldering bit, to enable the same rapidity to be maintained as when soldering tin-plate, copper or brass articles, and also a solder that will withstand indefinite exposure to the atmosphere. This would then enable intricate articles in sheet aluminum to be joined easily and manufactured, which at the present time is a tedious operation. It is for this reason that commercial articles of aluminum having soft soldered joints are rarely sold. Usually the articles are cast, spun, pressed or drawn from one piece of the metal, or, if it is necessary to join one piece to another, welding, riveting or screwing is employed.

Why Aluminum is Difficult to Solder

Perhaps it is worth while to explain some of the difficulties in soldering aluminum and finding an effective and easily used solder. The problem has been very difficult owing to the oxidizing characteristics of the metal. The chief reasons for the difficulty are as follows:

1. The formation of an almost imperceptible but very persistent film of oxide on the surface of the metal; this

film of oxide, which is always present, is intensified at soldering temperatures and, being very refractory, prevents ordinary soft solders from alloying with the metal and forming a strong joint.

2. The highly electro-positive character of the metal causes electrolytic action with low-temperature solders containing negative metals like lead, the result being automatic disintegration at the joint. Especially is this the case in damp situations favorable to galvanic action.

3. The high heat conductivity of the metal renders local heating to alloying temperature a tardy and difficult matter; this trouble increases as the size of the article worked on increases; hence the heat is conveyed from the soldering bit and solder so rapidly that they are chilled quickly, and therefore the solder does not become sufficiently liquid to flow readily.

An experience extending over the time that has elapsed since aluminum became extensively used has demonstrated that the metal can be soldered, but not so readily and effectively as other metals. When soldering aluminum, it is essential that the oxide film on the surface should be removed before cohesion with the solder can take place, and as it forms again on exposure to the air instantaneously, it is necessary that the removal of the oxide and the covering with solder should be simultaneous. In soldering other metals the oxide can be removed chemically; with aluminum this has been a very difficult problem, although Otto Nicolai, of Boppard-on-the-Rhine, has invented a flux which, it is stated, combines with the alumiuna and produces a compound that remains fluid during the process of soldering, thereby completely counteracting the effect of the oxide on the surface of the metal. However, in the absence of a suitable flux the oxide must be removed mechanically by abrasion.

Tinning Aluminum Preparatory to Soldering

Tinning the surfaces of aluminum preparatory to soldering is an important factor; also, when soldered joints in sheet aluminum are needed, the distance of the overlap of the pieces to be joined should be much less than that usually allowed for other sheet metals. The reason for this is that the solder will not flow into an aluminum joint, even when tinned, by capillary attraction as it does into tin, brass or copper joints. The process of tinning is accomplished by heating the surfaces to be soldered to a temperature somewhat above the fusing point of the solder used, a satisfactory tinned surface being obtained by rubbing with the point of a well tinned soldering bit so as to remove the film of oxide and allow the solder to act upon the clean surface, all in the same motion, removing any dross that may have formed. After the surfaces to be united are thus tinned, they may be soldered together by pressing the tinned surfaces in contact, again heating the metal and solder to the desired temperature, and finally by rubbing thoroughly with the hot soldering bit the surface carrying the liquid solder. In the actual operation of soft soldering aluminum, it is essential that all joints should be kept under slight pressure until the solder has thoroughly set, this method thus preventing disruption of the joint.

Effect of Dampness on Aluminum Soft Solders

The following is a case in point, with reference to the disintegration of soft solders in damp situations. During the month of March, 1910, the writer made two aluminum vessels of triangular shape 12 inches in depth, sheet aluminum 0.036 inch in thickness being used. The joints were made by using a solder composed of tin, zinc, aluminum and phosphor-tin. One of the vessels was used for filtered water and the other for dry materials; both were made at the same time and by precisely the same process. After a lapse of a few months the vessel that had been used for the water came back for repairs, the defect being that the joints were leaking; upon examination, it was found that the solder had badly disintegrated; in fact, the greater portion of the solder could easily be stripped off the aluminum, whereas with the other vessel the solder is still in good condition. The writer has several soft soldered specimens of aluminum, as well as aluminum soldered to brass, that were jointed in 1906. These are also perfect, but it must be stated that the specimens referred to are not exposed to severe conditions, such as spray of sea water (which rapidly deteriorates aluminum soft solders), or a damp atmosphere.

Fluxes for Aluminum Soft Solders

A large variety of soldering fluxes to use with aluminum soft solders have been tried with more or less success; *viz.*, ammonium chloride, borax, copper chloride, cadmium iodide, lard oil, rosin, stearin, silver chloride, stannous chloride, tallow, vaseline, zinc chloride, etc.; in fact, it would probably be more difficult to mention what has not been tried as a flux to use with aluminum soft solders. However, stearin has several properties which make it a valuable soldering flux, and it can be used successfully with a number of the solders listed in the table previously referred to. The rapidity with which a flux acts is an important factor in its usefulness. Occasionally the writer has noticed a flux advertised in the columns of various engineering periodicals as an ideal soldering flux for all metals except aluminum, thus showing the difficulty of finding a suitable flux for aluminum soft solders. An ideal soldering flux which would appear to be needed at the present time for use with aluminum soft solders, would be a flux that would rapidly dissolve the oxide film and combine with the alumina, to produce a compound that would remain fluid during the soldering operation. This would then allow the solder to penetrate the liquid compound and thoroughly alloy with the metal, although in many instances fairly good results are obtained without the assistance of a flux; especially is this the case with soft solders containing various percentages of phosphor-tin. This may possibly be explained by the fact that these solders probably owe their adhesiveness to the great affinity that phosphorus has for oxygen. For instance, if a molten alloy containing phosphorus is placed upon aluminum, there is naturally a tendency to absorb oxygen from the impure film on the surface of the aluminum as well as from the surrounding air. When making these phosphor-tin solders designated in the table by the letters *B*, *G*, *L*, and *N*, respectively, to avoid loss of the more easily volatile of these metals, it is advisable to melt the aluminum first, then add the zinc, tin, and phosphor-tin, in the order named. To obtain a soft solder that may be worked at a comparatively low temperature, to enable the soldering bit to be employed solely, the solder is mostly composed of metals that possess low melting points, such as bismuth, cadmium, tin, etc., as these metals readily combine in all proportions when fused together. In the case of solders that melt at higher temperatures, it will be necessary to use a blowpipe flame or a bunsen burner as a subsidiary; care should be taken that any flame used is free from free carbon.

Soldering Bit for Aluminum

An aluminum soldering bit will be found to be far superior to the ordinary copper bit when soldering aluminum, the point and the joint being kept much cleaner during the soldering operation. Another advantage is that the point and slopes of the soldering bit can be tinned with the same flux as that used for the joint; a soldering bit of any other metal has a tendency to discolor the aluminum and to form alloys with the metal and the solder. More care, however, must be exercised in the manipulation of the aluminum soldering bit, because its melting point is lower than that of the ordinary copper soldering bit. It should be the aim of the mechanic to so use the soldering bit that its point or "face" remains tinned; re-tinning involves loss of time and frequent filing quickly wears it away. In addition, it is essential that both the tinning and soldering should be thoroughly done, and performed quickly to get good results. The quality of the workmanship has a very great influence on the permanence of the work.

Pointers on Soldering Aluminum

1. Remember that the metal cannot be soldered as readily and successfully as other metals; if you expect that it can, you will be disappointed.

2. Never attempt to solder aluminum until the surfaces to which the solder is to be applied have been thoroughly cleaned, as aluminum solders adhere only to bright and clean surfaces.

3. Do not expect to get good results with poorly prepared tools; good tools are essential to good soldering.

4. The surfaces to which it is intended that the solder shall

adhere should be thoroughly "tinned" in order to get good results.

5. Before attempting to solder, the metal near the joint to be soldered should be raised almost to the melting temperature of the solder.

6. Remember that both the tinning and soldering must be done thoroughly to get good results.

7. Any blowpipe flame that is used for heating must be free from free carbon. A large blowpipe flame should only be employed in "heating up" the parts to be soldered—not on the solder itself. Do not overheat the metal or its strength will be impaired.

8. A soldering bit of pure aluminum is essential to the success of the operation; the ordinary copper bit tends to alloy with the metal composing the solder and to discolor the metal.

9. Do not expect the solder to flow with such rapidity as in soldering such metals as tin-plate, brass, and copper; aluminum solders generally flow sluggishly.

10. A solder should not be considered perfect until it has been subjected to a duration test.

11. Avoid wide seams when jointing sheet aluminum. The solder will not flow into the joints, even when tinned, by capillary attraction as when soldering other sheet metals.

12. Do not expect the solder to pull the joint together, but see that the joint is kept under a slight pressure until the solder is thoroughly set.

13. Aluminum solders should not be stored in a damp atmosphere. If kept for some time, the solder deteriorates; hence, when required for use the metal does not flow so readily.

14. Good results will not be obtained if the metal is soldered in a dilatory manner; smartness is the keynote to successful aluminum soldering.

Hard Soldering or Brazing Aluminum

The process of hard soldering or brazing aluminum differs from ordinary soft soldering principally because the uniting metal or solder is chiefly composed of copper and zinc; hence a much greater degree of heat is necessary, although other metals are occasionally added. Whatever may be the composition of the uniting metal or solder, it is always desirable to retain to a great extent the strength, malleability, fusibility and color of the metal to be jointed; therefore, the composition of the uniting metal should contain a certain amount of aluminum. As these hard solders have a high melting point they cannot be applied with a soldering bit, and a hearth fire or a powerful blowpipe must be used. Hard soldering is generally termed "brazing." The process is one of the oldest of the mechanical arts, and was well known to the ancient Egyptians. The uniting metal or solder is known by various names, *viz.*, spelter, spelter-solder, brazing brass, brazing solder, brazing-spelter, etc. Brazing or hard soldering is used on most metals where greater strength is required than can be given by soft solder, or where the work has to withstand a degree of heat that would cause soft solder to fuse.

The fusing point of the solder used should be as close as possible to that of the article to be brazed, as a more tenacious junction can thus be secured. In the actual operation of brazing, joints will often appear to be sound, but when the superfluous solder is removed it will be discovered that this is what held the pieces together. When the extra material is cleaned off, defects caused by the solder not having run into the joints satisfactorily can be detected. Aluminum is without doubt one of the most difficult metals to braze effectively. This is largely due to the difference in the fusibility of aluminum oxide and aluminum metal. From a mechanical point of view, to attempt to braze aluminum is evidently a mistake; the metal is far more likely to fuse than many of the brazing compounds employed.

The coefficient of expansion of aluminum is considerable and a piece of work may be rendered useless owing to the deformation it has received during the brazing process. The essentials of a brazed joint are the contact of absolutely clean surfaces free from oxide and dirt. In aluminum we have an astonishingly bright and clean metal, but the bugbear to successful brazing is the difficulty in eliminating the oxide that is so refractory at brazing temperatures, and which effectively prevents that intimate connection (which is so essential) between the brazing solder and the surfaces to be joined. It is well known that brazing or hard soldering is generally preferred to soft soldering where superior strength is required, particularly at high temperatures; but aluminum and the aluminum-zinc alloys do not lend themselves in a satisfactory manner to brazing. A number of interesting experiments were made quite recently in a large engineering works with the brazing of various sheet aluminum articles. Several types of joints, brazing solders and fluxes were employed. In the experiments referred to the results were unsatisfactory in that fusing of the aluminum took effect before a perfect joint was obtained. Until the remarkable advance made during the last few years with the development of the autogenous method of jointing various metals, brazing was considered the ideal process where strength and durability were required. Even today the question is frequently asked by many mechanics, that if aluminum cannot readily and effectively be soft soldered "why not braze it." Obviously, as will be gathered from the foregoing, the brazing of aluminum, strictly speaking, is at present far from being a satisfactory commercial proposition.

* * *

A MACHINE GREENGOODS GAME

It is not always the farmer who buys the gold brick or tempting roll of imitation greenbacks. Gullible human nature is found in the highways and the byways of the great cities as well as on the farms. The purchase of de luxe editions of Dickens and other standard authors at prices ranging up to $50,000 or $75,000 recently aired in the trial of a book agent captain of industry, proves this. But the exploitation of machines as a bunco game is not so common. Perhaps it requires too much brains of the promoter to make such games profitable—but they have been worked in some cases with success.

A few years ago an interesting and promising device for boring square and polygonal holes in metal was brought to the attention of the public. The apparatus could be attached to a lathe, milling machine or drilling machine, and would quickly and accurately drive a triangular cutting tool through a piece of steel, producing a regular square hole with smooth sides and sharp corners. However, as might have been anticipated by a mechanical expert familiar with the general demand for such tools, it never won great commercial success. The machine was interesting, if not fascinating to watch. Its work was so different from that of the ordinary machine tool that it attracted attention way out of proportion to its actual value; but interested attention did not mean sales and the necessary cash to carry on the business.

After a year or two of work the original promoters of the machine sold out to a gentleman of little or no mechanical experience but who had a persuasive tongue and manner. He did not try to interest legitimate customers but frequented offices and homes of men and women who had money to invest and no knowledge of the needs of manufacturers. It was much easier and more profitable to sell stock in the boring machine business than to sell machines.

Some of the stories told to prospective customers were weird and ludicrous. The promoter made a lawyer believe that the machine had great possibilities in bridge building plants. He asserted that no machine existed for boring square holes, and that bridge builders would welcome a machine of this type which would enable them to use bolts in bridges with square shanks of the carriage bolt variety! They would be able then to assemble bridges much more rapidly and cheaply, inasmuch as the workman could work single-handed, not requiring a helper to hold a wrench on the head of the bolt when he screwed up the nut! The possibilities in the manufacture of hardware were also pointed out, both promoter and victim being in blissful ignorance of the fact that the punch press provides a means for cutting holes of any shape in sheet metal, at a speed a hundred times greater than is possible with any geometric boring machine.

The moral of this story, if it has any, is that before investing your money in any mechanical proposition, it is well to secure the advice of a disinterested person who knows something about the conditions of manufacturing and the probable value of the device to be exploited.

INDEX DRILLING AND TAPPING ATTACHMENT FOR BROWN & SHARPE AUTOMATIC SCREW MACHINE*

A RAPID AND ECONOMICAL DEVICE FOR PRODUCING ATOMIZER PARTS

BY W. F. GRADOLPH†

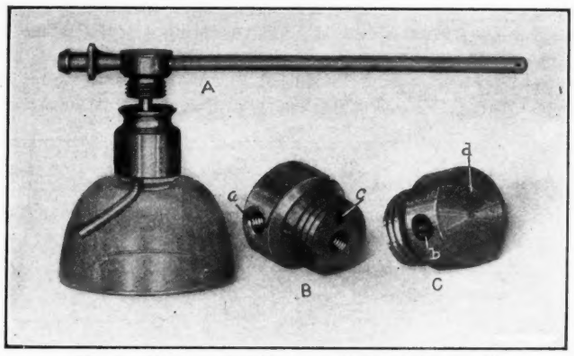

Fig. 1. Atomizer Top Cap assembled and dismantled

THE tooling equipment for making atomizer parts cheaply and rapidly on a screw machine presents many problems. The handling of small parts in different machines greatly increases the cost, and it is always the aim to reduce second operations to a minimum. The Brown & Sharpe automatic screw machine lends itself admirably to the application of many different attachments, and in the following article an attachment of the indexing type operated from the cross-slide for drilling and tapping will be described.

The part to be made is shown assembled on an atomizer at *A* in Fig. 1, and also at *B* and *C* in the same illustration, and is one of several hundred parts which are assembled into De Vilbiss atomizers manufactured by the De Vilbiss Mfg. Co., Toledo, Ohio. The part, which is an atomizer top cap, before having the cross holes drilled and tapped, is formed, drilled, center-hole tapped, threaded on the outside and cut off in the regular way in a Brown & Sharpe automatic screw machine. It is then brought to the Brown & Sharpe machine shown in Fig. 2, and is placed in the vertical magazine hopper *A*. The hopper is located at the rear end of the machine and by means of an attachment fastened to the regular stock-feeding mechanism, the parts are fed through the spindle to the special chuck *B*. For performing all the operations hereafter enumerated, the spindle of the machine is stopped, that is, it is held stationary with a brake, and the work is in no case rotated, all the tools held in the turret or on the cross-slide being power-driven.

After feeding the parts to the chuck and gripping, the first operation is to drill holes *a* and *b*, Fig. 1. To do this, the turret is indexed and the jig *C*, Fig. 2, is brought forward carrying bushings which guide the drills accurately and enable them to start without deflecting on the circular faces of the work. Drills *D* and *E* are then withdrawn, whereupon the turret is again indexed and drill *F* is brought into position. This tool then drills hole *c* in the work shown in Fig. 1. It will be noted here that hole *c* is off center; this hole is produced by means of a drill-holder held in an offset bushing located in the turret. As the work is not rotated, the offset of the bushing controls the position of the hole in the work relative to the position of the central hole. This particular hole has two diameters as shown by *c* and *d*, and consequently it is necessary to hold two different sized drills in the turret. These drills are driven in the ordinary way by means of the Brown & Sharpe standard turret drilling attachment driven by belt *H* which, through bevel gears in the turret itself, drives the drill-holders holding drills *F* and *K*.

After drilling the hole *c*, the index head *I*, Fig. 2, indexes one-half revolution and brings the tap *J* into position. This attachment is one of the most unique tools connected with the set-up and will be described separately later. Hole *a* is then tapped while drill *K*, held in the turret, drills the small hole *d* in the work; that is, it projects completely through the work guided by the hole *c* previously drilled. After hole *a* is tapped and hole *d* is drilled, both tools withdraw and the chuck releases the work, which is then ejected and a new piece is brought into position. The index head on the cross-drilling attachment then turns around half a revolution, bringing the drill *D* into position again for the next piece.

The Index Cross-slide Drilling and Tapping Attachment

The index cross-slide drilling attachment shown set up on the No. 2 Brown & Sharpe automatic screw machine in Fig. 2 is shown in detail in Fig. 3, where a better idea of its construction can be obtained. Referring to the latter illustration, it will be seen that the attachment consists primarily of a body *A* enclosing a driving and indexing mechanism. Casting *A* is fastened to the rear cross-slide in the usual manner and carries an indexing drum *B* that is indexed by means of wormwheel *C*, receiving power from the worm *D* driven by a pulley *E* belted to the overhead works. The drilling and tapping spindles *F* and *G*, respectively, are driven by a grooved pulley, which is belted to the overhead works and drives these spindles through gearing. The drilling spindle is driven direct by means of gears *I* and *J*, whereas the tapping spindle is driven in one direction by gears *K* and *L*, friction cone *O* and cup *Q*, and in the other direction through gears *I*, *J*, *M* and *N*, friction cone *O* and cup *P*. Cone *O* is made of cast iron, whereas friction cups *P* and *Q* are made from phosphor-bronze. Gear *N* is screwed onto the extended shoulder of cup *P* and gear *L* is screwed onto the extended shoulder of cup *Q*. The pulley shaft is provided with a left-hand thread, as is gear *K*. The spindles *F* and *G* rotate in phosphor-bronze bushings.

The operation of the friction device is as follows: When the cross-slide advances, the pressure of the tap against the work forces friction cone *O* back into contact with cup *Q*, power being obtained for the tap through gears *K* and *L*. This continues until the cross-slide has reached the extreme forward movement, whereupon it drops back, and in dropping

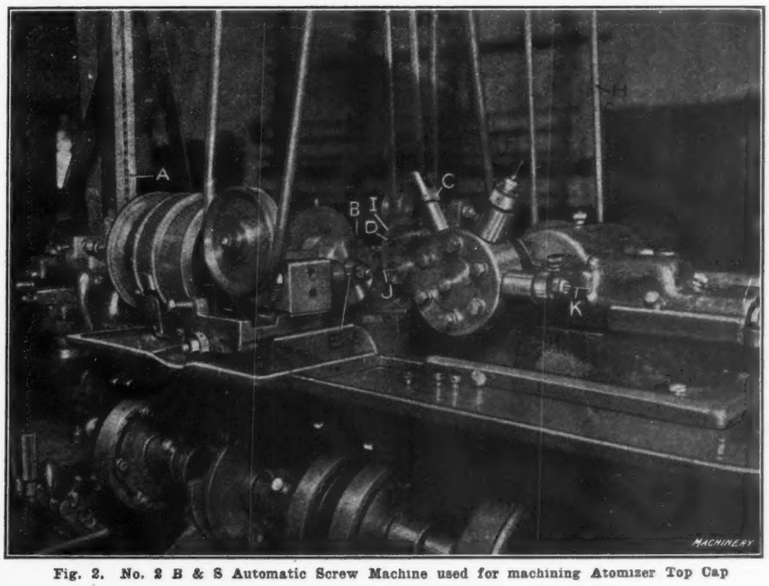

Fig. 2. No. 2 B & S Automatic Screw Machine used for machining Atomizer Top Cap

* For further material on Brown & Sharpe automatic screw machine work, see "Magazine Attachments" in MACHINERY, February and March, 1912; and "Milling, Cross Drilling and Burring Attachments" in September, October, November and December, 1911.

† Address: The De Vilbiss Mfg. Co., Toledo, Ohio

back the tap still being in the work, draws friction cone *O* into contact with friction cup *P*. The drive is then through gears *I*, *J*, *M* and *N*, driving the tap in the opposite or left-hand direction, and consequently withdrawing it from the hole in the work.

The Indexing Device

Another very interesting feature of this cross-drilling and tapping attachment is the indexing device for bringing the drill and tap consecutively into operation. As was previously mentioned, the drum carrying the entire mechanism is enclosed and carries a wormwheel meshing with a worm, which is driven by a tight pulley *E*. The shaft carrying tight pulley

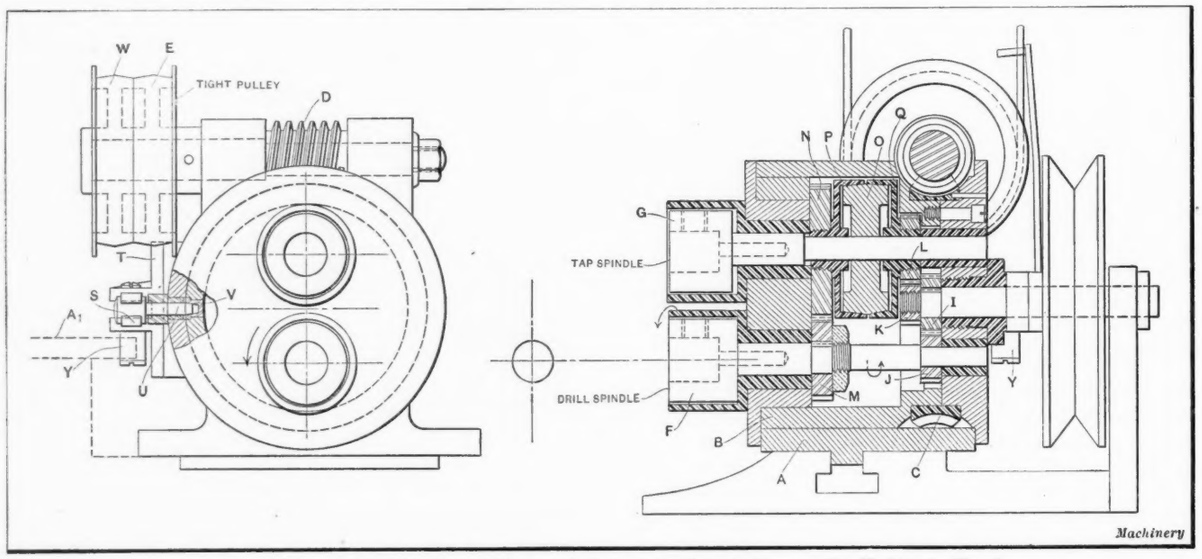

Fig. 3. Details of Cross-slide Index Drilling and Tapping Attachment shown on the Machine in Fig. 2

E also carries a loose pulley *W* so that when no motion of the drum is required the belt is shifted over onto the loose pulley. Just as soon as the drill or tap is released from the work, the roll *Y* held on fulcrum arm *S* comes in contact with a cam A_1 fastened to the side of the machine. This forces in arm *S* which is fulcrumed in the bracket *T*, withdrawing the locating plunger *U* from the indexing bushing *V*, and at the same time shifting the belt from the loose pulley *W* onto the tight pulley *E*, the details of this mechanism being illustrated much more clearly in Fig. 4. When the belt is shifted onto tight pulley *E*, the cylinder *B* makes one-half revolution, but before this is completed the cross-slide is advanced and thus withdraws the locking plunger from the action of cam A_1. The indexing plunger rides on the cylinder holding the belt shifter over against the tension of the coil spring B_1 until the half revolution is completed, whereupon the index pin drops back into the bushing, allowing the spring B_1 to push the shifter outward, shifting the belt onto loose pulley *W*. The commendable feature of this attachment is its compactness and reliability. We have been using it for a considerable time and the tap breakage has been practically nil. Its simplicity commends it to those interested in screw machine work and screw machine tools and equipment.

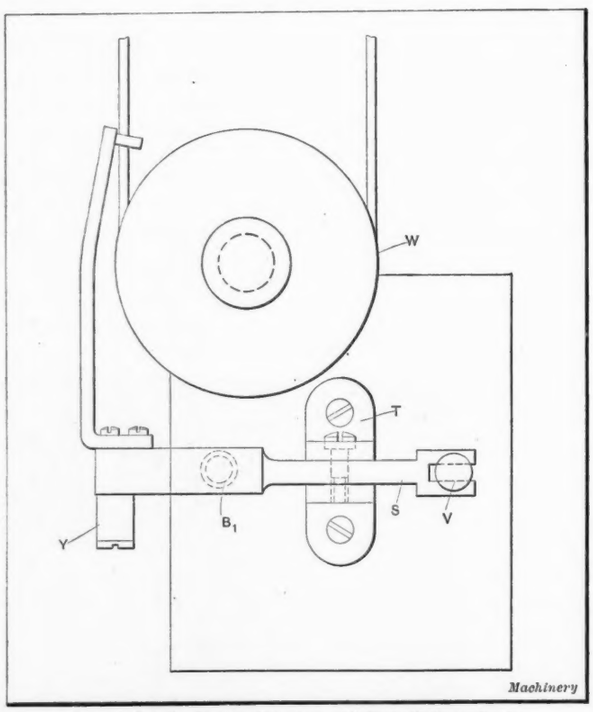

Fig. 4. Detail showing Indexing and Belt Shifting Device

INTERNATIONAL ENGINEERING CONGRESS NOT ABANDONED

A report was current to the effect that the International Engineering Congress to be held in San Francisco, Cal., September 20-25, 1915, was to be abandoned because of the European war. The committee of management has issued a statement correcting the erroneous impression, and stating that the five governing bodies of the five national societies under whose auspices the congress is to be held, recently gave the matter careful consideration and unanimously confirmed their original pledges to support it. Communications have been received from various foreign countries throughout the world including those located within the war zone, indicating that a large majority of the papers originally solicited for the congress will be turned in on time, and that the congress will be truly international in character. The total number of papers contemplated was about 290 and of this number about 220 are definitely promised.

The meetings will be held in the new auditorium building in the civic center of San Francisco in which the Panama-Pacific International Exposition authorities have reserved assembly, section and committee rooms for the week of the congress, sufficient to fully meet all requirements.

The committee appeals for the strong and immediate support of American engineers; in view of the conditions brought about by the war, it is imperative that they subscribe promptly. Subscriptions should be sent to W. A. Cattell, secretary, or W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

* * *

As a producer of raw materials, the United States stands in the first place among the nations; its production of iron ore is 44 per cent of the world's production; of copper, 55 per cent; of petroleum, 63 per cent; of coal, 40 per cent; of cotton, 56 per cent; and of wheat, 20 per cent.

DESIGNING CONE PULLEYS*

A NEW GRAPHICAL METHOD OF FINDING THE RADII, WITH EXAMPLES

BY ROBERT C. H. HECK†

THE dotted outline in Fig. 1 represents a pair of equal pulleys having a diameter D_o and placed at a distance S between the centers or axes. The full lines shows a pair of unequal pulleys on the same axes, with radii R and MR, respectively. If absence of slip is assumed, M is also the ratio of the turning speed of the small pulley to that of the large one. In order that the length of belt shall be the same in these two cases, the mean diameter D_m of the unlike pulleys, which equals $R + MR$ or $R(1 + M)$, must be a little less than D_o. The method now offered consists in expressing the relation as a formula:

$$D_m = D_o \times (1 - Q) \quad (1)$$

The exact value of the small fraction Q is then calculated for a wide range of conditions, and these values are plotted in a large-scale diagram. From this diagram, the factor Q can be read with an accuracy far greater than is attainable in any of the graphical constructions commonly used for finding the diameters of cone-pulley steps. The corrective factor Q increases with the pulley ratio M and also increases as the distance S gets relatively smaller. By introducing another proportionality factor, we have:

$$S = ND_o \quad (2)$$

Then by having Q depend upon M and N, the diagram is made general; it is independent of, but applicable to, any particular dimensions. In the main diagram, Fig. 3, the base (for both sections) represents M, *i.e.*, the diameter ratio and ideal speed ratio of the steps. It is laid out on a logarithmic scale, beginning with equal pulleys at the left-hand edge, for which $M = 1$ and $\log M = 0$; and running to $M = 10$, which is beyond the limit of practice. The ordinate represents Q to a uniform scale, measured downward from the top of the diagram because it it is a subtractive quantity. In the lower left-hand section, the scale of Q is two and one-half times as great as in the main diagram. Each curve is drawn for the particular value of shaft-distance factor N with which it is numbered. The use and full meaning of the diagram can best be made clear by means of numerical examples.

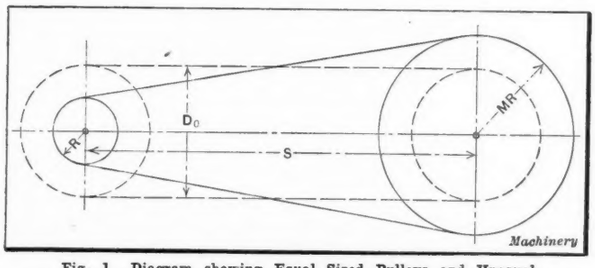

Fig. 1. Diagram showing Equal Sized Pulleys and Unequal Pulleys for Same Length of Belt

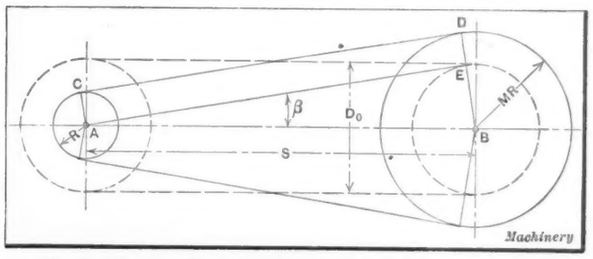

Fig. 2. Diagram illustrating Method of Procedure in calculating Values for plotting Diagram shown in Fig. 3

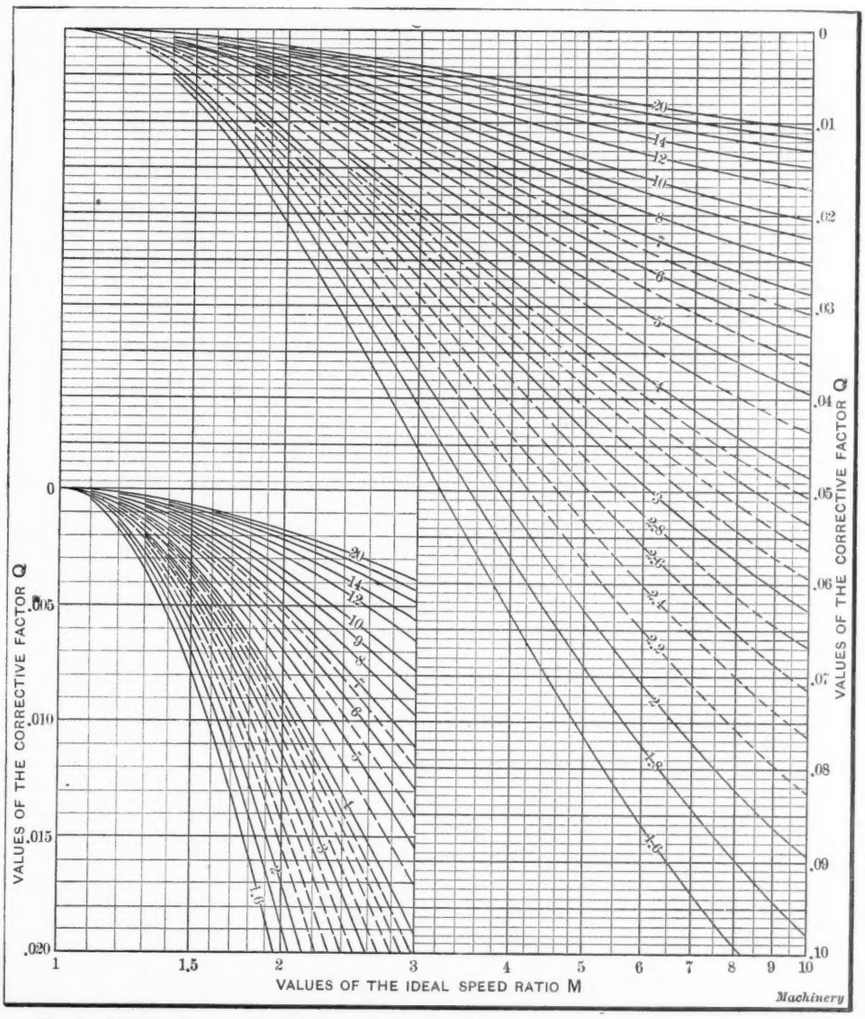

Fig. 3. Diagram for determining Values of Corrective Factor Q from Corresponding Values of Speed Ratio M and Distance Factor N

Example 1: In Fig. 1 let $D_o = 12$ inches and $S = 48$ inches, so that the value of N is 4. Find the diameters for a pair of pulleys which will fit the same belt and have a speed ratio of 3 to 1. The vertical line for $M = 3$ is crossed by the curve for $N = 4$ at $Q = 0.0192$, and 1.92 per cent of 12 inches is 0.230 inch, so that D_m is 11.77 inches. Since $D_m = R(M + 1)$ and M is 3, the radius R of the small pulley is $11.77 \div 4 = 2.9425$; and either by subtraction as $(D_m - R)$ or by multiplication as MR, the other radius is found to be 8.8275 inches. The diameters are then $D_1 = 5.885$ inches and $D_2 = 17.655$ inches. This is the simplest problem that arises; and even when interpolation must be made in the diagram for both M

* For information on the design of cone pulleys previously published in MACHINERY, see "Cone Pulley Radii," September, 1905.

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and N, it is easily possible to get D_m accurate to the nearest 0.01 inch. On the question of considering or disregarding the belt thickness, it may be remarked that this is of much more importance as affecting belt length and velocity ratio than in its influence upon the design for constant length around different steps. As between $D_m = (1-Q)D_o$ and $D_m + T = (1-Q)\ (D_o + T)$ the difference in D_m is only QT; and unless Q is unusually large this is practically negligible.

Example 2: Design a pair of five-step equal cones with a middle diameter of 10 inches, to be placed 54 inches apart and to give speeds in a geometric progression having the term ratio 1.4. The middle step being fixed and the two sides alike, it is necessary to design only two steps. For these M will be 1.4 and 1.4^2 or 1.96. Since $N = 5.4$, by referring to the diagram and reading from the enlarged section, we get $Q = 0.0016$ and $Q = 0.0062$. For the step nearest the middle $D_m = 9.98$ inches; $R_1 = 9.98 \div 2.4 = 4.16$ inches; $R_2 = 5.82$ inches. For the end step $D_m = 9.94$ inches; $R_1 = 9.94 \div 2.96 = 3.37$ inches; $R_2 = 6.57$ inches. The five diameters will therefore be 6.74, 8.32, 10, 11.64 and 13.14 inches, respectively.

Example 3: With no allowance for sag, find the length of belt around a 12- and 60-inch pulley pair with 20 feet between shaft axes. This problem must be worked by trial solution. First get N as for the known value of D_m, which is 3 feet; with $S = 20$ feet the value of N becomes 6.67. Referring to the diagram with this value and with $M = 5$, Q is found to be 0.0205. Then $D_o = D_m \div (1-Q) = 36 \div 0.9795 = 36.755$ inches $= 3$ feet ¾ inch. Comparing this result with $S = 20$, the more exact value of N is found to be 6.53 and the corresponding value of Q is 0.0208, which makes $D_o = 36.765$ inches. Obviously, the first approximation is, in this case, good enough for all practical purposes. From Fig. 1, it is evident that the dotted belt length is the circumference of the circle of diameter D_o plus $2S$. To be exact, add one belt thickness (say 0.22 inch) to D_o, getting 36.99 inches. The circumference of a circle of this diameter is 116.21 inches, or approximately 9 feet 8.25 inches, and the whole length of the belt is 49 feet 8.25 inches. When working from a given value of D_m to an unknown value of D_o, as in the present case, it is necessary to divide by $(1-Q)$ which means a troublesome calculation. Changing to an operation for which the slide rule is amply accurate is effected by calculating and tabulating a second corrective factor from the relation:

$$\frac{1}{1-Q} = 1 + Q_1 \qquad (3)$$

Then instead of dividing 36 by $(1-Q)$ or 0.9795 as in the last example, it is a much simpler numerical operation to look up $Q_1 = 0.0210$ and add to 36 the Q_1 fraction of itself or 0.755 inch. Values of the factor Q_1 are given in the table.

VALUES OF FACTOR Q_1

Q	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009
0.00	0.0000	0.0010	0.0020	0.0030	0 0040	0.0050	0.0060	0.0071	0.0081	0.0091
0.01	0.0101	0.0111	0.0121	0.0132	0.0142	0.0152	0 0163	0 0173	0.0183	0.0194
0.02	0.0204	0.0215	0.0225	0.0235	0.0246	0.0257	0.0267	0.0278	0.0288	0.0299
0.03	0.0309	0.0320	0.0330	0.0341	0.0352	0.0363	0.0373	0.0384	0.0395	0.0406
0.04	0.0416	0.0427	0.0438	0.0449	0 0460	0.0471	0.0482	0 0493	0.0504	0.0515
0.05	0.0526	0 0537	0.0549	0.0560	0.0571	0.0582	0 0593	0.0604	0.0616	0.0627
0.06	0.0638	0.0650	0.0661	0 0672	0 0684	0.0695	0.0707	0.0718	0.0730	0.0741
0.07	0.0753	0.0764	0.0776	0.0788	0.0799	0.0811	0.0823	0.0834	0.0846	0.0858
0.08	0 0870	0.0881	0.0893	0.0905	0.0917	0.0929	0.0941	0.0953	0.0965	0.0977
0.09	0.0989	0.1001	0.1013	0.1025	0.1038	0.1050	0.1062	0.1074	0.1086	0.1099

Machinery

Example 4: Design a pair of four-step equal cones, to give speeds in a geometric series with the ratio 1.2, the largest diameter being 16 inches and the distance between centers 10 feet. Let X stand for the ratio between successive speeds or values of M. There is here no middle pair of equal steps, with $M = 1$, as in Example 2; but the two steps near the middle are each distant by half of interval X from the state $M = 1$. In a geometric series half an interval is measured by the square root of the term factor $X = 1.2$. Then the series of values of the speed ratio M will be $X^{-\frac{3}{2}}$, $X^{-\frac{1}{2}}$, $X^{\frac{1}{2}}$, $X^{\frac{3}{2}}$, each being multiplied by X to get the next, and the product of the two middle terms being unity. With like cones, only steps Nos. 3 and 4, in which M is greater than 1, need be considered. Let $M_1 = X^{\frac{1}{2}}$ or $\sqrt{X}$, $M_2 = X^{\frac{3}{2}}$. For $X = 1.2$, $\log X = 0.07918$; whence $\log M_1 = 0.03959$, $\log M_2 = 0.11877$; $M_1 = 1.095$, $M_2 = 1.315$. With $M = 1.315$ and the largest diameter $D_4 = 16$ inches, the smallest diameter D_1 is $16 \div 1.315 = 12.17$ inches. Then $D_m = 14.09$ inches and $N = 120 \div 14.09 = 8.53$. For $M = 1.32$ and $N = 8.5$, $Q = 0.0007$ and there is no occasion for a second trial. The effect is to make D_o only 0.01 inch larger than D_m for the end steps, while for the middle steps D_m will be indistinguishable from this value of D_o. Using $2D_m = 28.20$ inches, we get $D_2 = 28.20 \div 2.095 = 13.46$ and $D_3 = 28.20 - 13.46 = 14.74$. The four diameters are now found to be 12.17, 13.46, 14.74, and 16 inches, respectively. The data for this problem lie in the region where it is commonly considered proper to keep the sum of diameters constant, and the solution shows how insignificant is the error involved in so doing. It appears that for ordinary countershaft conditions, especially under the modern plan of a small speed range on the belt cones, the error due to a constant sum of diameters is very small. But where cones are put close together and have a large speed range, as in countershafts for grinding machines, the correction by Q must, of course, be made. There is nothing novel about these statements. The point is the advantage of the present method as a means of securing accurate results, without the uncertainty due to graphical error which is multiplied if the layout is too big to be drawn full size. A final example at the opposite extreme of conditions will complete the exposition of this method.

Example 5: A foot-power lathe has steps 3, 4 and 5 inches in diameter on the headstock cone, while the diameter of the largest step on the driving cone is 20 inches and the distance between axes is 30 inches. Find the other two diameters on the large cone. The trial method of Example 3 must surely be used here, with perhaps several trials. For the step given, $M = 20 \div 3 = 6.67$ and $D_m = 23 \div 2 = 11.5$. If this were D_o, N would be $30 \div 11.5 = 2.61$. Knowing that D_o will be larger, try $N = 2.4$ and get $Q = 0.064$. This will make $D_o = 11.5 \div 0.936 = 12.29$ inches and $N = 30 \div 12.29 = 2.44$, which shows that the guess was a good one. A closer value of Q is now 0.0633, for which $Q_1 = 0.0676$ and $D_o = 11.5 + 0.78 = 12.28$ inches. This gives $N = 2.443$ exactly. Having thus established the value of D_o, the procedure for the unknown steps will be to assume a trial value of Q, get D_m and M and check back to Q. Take the step for which $R = 2$ inches. Try $Q = 0.058$, $D_m = 12.28 - 0.71 = 11.57$ inches, $MR = 9.57$ inches and $M = 9.57 \div 2 = 4.79$. For $N = 2.44$ and $M = 4.79$ the diagram gives $Q = 0.0497$. Try again with $Q = 0.050$; then $D_m = 12.28 - 0.61 = 11.67$ inches, $M = 9.67 \div 2 = 4.84$ and $Q = 0.0502$ from the diagram. This is close enough; then $D_m = 12.28 - 0.62 = 11.66$ inches and the diameters are 4 and 19.32 inches, respectively. From end step to second step the value of Q changes from 0.0633 to 0.0502 or by 0.0131. The next change will be smaller, perhaps about 0.010. Try $Q = 0.040$ and $D_m = 12.28 - 0.49 = 11.79$ inches. With $R = 2.50$ inches, $MR = 9.29$, $M = 3.72$ and Q is found to be 0.0695, which is near enough because a variation of 0.0005 in the value of Q means but 0.0006 inch in D_m. The diameter for this step is then 18.58 inches, and for the two cones the whole set of values is 3, 4 and 5 inches; and 20, 19.32 and 18.58 inches. The step differences are 0.68 and 0.74 inch for the large cone, as against 1 inch for the small one. In a problem of this sort it would be better to use a graphical method for approximate solution and then check to assure accuracy by means of the diagram here given.

Appendix

The method of determining the location of points for the curves in Fig. 3 is derived as follows: In Fig. 2 the dotted belt length is:

$$L = (\pi + 2N)\ D_o. \qquad (4)$$

The length around the unequal pulleys is:

$$L = (\pi - 2\beta)\ R + (\pi + 2\beta)\ MR + 2S\ \cos\beta.$$
$$= \pi\ (M+1)\ R + 2\beta\ (M-1)\ R + 2ND_o\ \cos\beta \qquad (5)$$

Letting $D_m = (M+1)\ R = (1-Q)D_o$, (6)

$$R = \frac{1-Q}{M+1} D_o.$$

$$(M-1)\,R=(1-Q)\,\frac{M-1}{M+1}\,D_o.$$

Substituting these values in Formula (5) and equating it with Formula (4) gives:

$$L=\pi(1-Q)D_o+2\beta\,(1-Q)\,\frac{M-1}{M+1}\,D_o+2N\cos\beta\,D_o$$
$$=(\pi+2N)D_o.$$

From the preceding we find:

$$Q=\left[2\beta\,\frac{M-1}{M+1}-2N\,(1-\cos\beta)\right]\div\left(\pi+2\beta\,\frac{M-1}{M+1}\right) \quad (7)$$

From Fig. 2 we find:

$$\text{Sin}\;\beta=\frac{M-1}{S}\,R=\frac{1-Q}{N}\times\frac{M-1}{M+1}. \quad (8)$$

Having Formulas (7) and (8), the problem is to find by trial solution the value of Q for given values of M and N. The steps are as follows: (*a*) Assuming a trial value of Q get sin β from Formula (8), taking it to correspond with the nearest minute of angle. (*b*) Look up cos β and compute the value of β in angular measure or expressed as a fraction of a radian. For this operation it is convenient to have made out an auxiliary table giving β for each degree up to say 30 and for each minute from 1 to 59. (*c*) Work out Formula (7), getting a computed value of Q. (*d*) With this value of Q recompute sin β by Formula (8) and compare it with the value taken at the start. In making the calculations represented by the diagram, Fig. 3, this was repeated until the two values of sin β agreed within 0.00005. The check is on sin β rather than on Q because the first value of Q is rough and merely guides the selection of sin β, whereas this sin β is definitely and precisely related to cos β and β as used in Formula (7). The calculation is rather laborious, although not so involved as might be inferred from a glance at Formula (7); but there is no practical reason why anyone should repeat it, nor would any usable requirement as to precision call for the printing of a numerical table of values of Q. The diagram is based on 295 calculated points and a good many more obtained by careful numerical interpolation.

* * *

EXPERIENCES OF AN APPRENTICE

BY APPRENTICE

Whenever a new man comes to work in our tool-room, he and I soon become acquainted, as it falls to my lot to show him where various tools are kept and to run errands for him, etc. I have several ways of sizing a new man up, one being to appear very much interested in his kit of tools. If his "mikes" are thrown into the tool-chest on top of other tools, his stock drops quite a few points in my estimation; if he owns no "mikes" at all, his stock goes down still farther; and lastly, if he singles me out in order to blow about the wonderful jobs he has done and the big money he always received before coming here, I put him down as a "bluff." That is part of the experience gained in three years' apprenticeship.

We had a world-beater of a toolmaker in our tool-room lately—until the boss decided otherwise. I will call his name Al because it was something else. The boss gave Al a dandy little die for piercing round holes and punching a number of oblong slots as his first job. Being in the business to absorb all the knowledge I can acquire, I naturally watched Al pretty closely in hopes he would use some kink new to me that he had gathered in his travels. He sprung no surprises until he had completed the die, when he started to make the oblong slotting punches. I wondered and watched until he had the oblong punches all screwed to the punch-plate and began to scribe the outline of the dies on the punches. Then I sauntered over to his bench and asked him if he were going to fit his blanking punches before he put holes in the punch-plate for the round punches.

He said, "Sure."

"Well, how are you going to transfer your round holes from the die to the punch-plate after you have the blanking or slotting punches fitted?"

"Are you looking for information?"

"I sure am."

"Well, I'll tell you kid; after I get those blanking punches fitted and screwed to the punch-plate, I'll take the die to the drill press and then put a piece of drill rod in the chuck just large enough to fit the holes in the die. Then, I will move the die until the drill rod enters it and then clamp the die to the table, raise the spindle, enter the blanking punches, resting the punch-plate on parallels, and substitute a drill for the piece of drill rod. Then I will drill the hole in the punch-plate and next shift the die to the following hole and so on. Do you follow me?"

"Yes, I follow you, but I'm a son-of-a-gun if I get you! How do you know that the center of the drill is in the same place as the center of the drill rod was? Those chucks run out something fierce."

"Ain't I just told you that I line up the chuck so that the drill rod just enters the die?"

"Yes, that is clear enough, but suppose you turn the chuck or the spindle one-half revolution; the drill rod will be pointing to one side of the hole. And when you drill down through the punch-plate, even though the punch-plate is perfectly parallel with the die, the drill is likely to run, even if the spindle happens to be at right angles to the table. When the drill breaks through the punch-plate, its center won't be directly over the center of the hole in the die. I don't see how it's possible for your round punches to line up with the die within a row of apple trees."

I knew by the expression on Al's face that he had followed me and saw the chance of errors in his method, but he is one of those fellows who won't admit he is wrong when it is clearly proved, especially if it happens to be a kid who is arguing. As is usual with a certain class when they recognize they have the wrong end of an argument, he instantly became abusive and attempted to silence me by offering to bet $10 that the punches would line up.

Ten dollars is quite a bet when it represents a week's pay, but Tom, who is an old toolmaker and who had been listening to the argument, slipped me a ten-spot and said: "Call his bluff kid." This brought Tom into the argument and Tom said, "The kid is right, Al. You have gone about the job backward. What you should have done was to bore your holes in the punch-plate at the time the die was bored and then make your round punches, leaving them a trifle longer than the blanking punches. Then you should have inserted your round punches in the punch-plate and fastened the blanks for the blanking punches to the plate, entering the round punches in the die far enough so that the blanking punches rested on the face of the die. Then the outline of the dies could be scribed on the face of the blanking punches. After milling the blanking punches to the scribed lines, the round punches should again be used as pilots to guide the blanking punches in the dies when shearing the punches. That is the easiest way and you will find it will do away with the practice of bending the punches or peening the punch-plate around the punches in order to crowd them this way or that and make them line up with the die."

Al replied that each man had his own way of making a die and added, "You probably have secured the best results with your way, while I have had the best results by mine."

Tom turned to his work, disgust plainly written on his face and indicated to me to get away from Al and let the matter drop. The next day, Tom sidled up to me and whispered, "Go over and ask Al what he is doing."

I looked over at Al, and sure enough he was busy pounding over the punches, then trying them in the die and then pounding them back a little. I tried to look unconcerned as I stepped to Al's bench, and after I stood watching the operation of punch bending a minute or two without either of us speaking, Al volunteered the information that the confounded parallels were "out."

What I cannot understand is why in the face of the arguments in favor of time-tried methods and the trouble that Al experienced, such men will start their next job exactly as they did the last. Tom says those fellows have missed their vocation; if they took an interest in their work, they would never make the same mistake twice, and furthermore, when a man is cut out for a toolmaker, he will instantly recognize the value of a principle and will quickly adopt a better way of doing any job at hand.

FORMING A WIRE IN THE AUTOMATIC SCREW MACHINE

BY E. WHITNEY

The threaded wire shown in Fig. 1 is finished completely in a No. 2 Brown & Sharpe automatic screw machine. As the automatic machining of this piece involves some unusual practice the writer will offer a few suggestions in regard to certain conditions which, for economical production, should either exist or be put into effect. First, the stock for work of this kind should be of soft metal and of small diameter, not to exceed ⅛ inch in any case. Second, the bend or part to be formed should be of a simple nature and not interfere with or supersede any regular screw machine operation. Third, the work should be placed on a heavy machine, such as the ⅞-inch Cleveland, or the No. 2 Brown & Sharpe. If the preceding suggestions are followed, work of this nature may be performed not only automatically but simultaneously with the other operations, and with but one setting of the machine. Although the screw machine production alone would be greater if the piece were made on a smaller machine, the combination of all operations will greatly reduce the total cost of machining the piece and justify the work being performed on the larger machine.

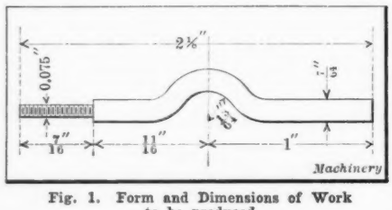

Fig. 1. Form and Dimensions of Work to be produced

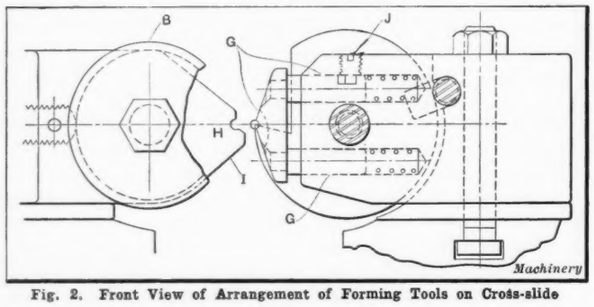

Fig. 2. Front View of Arrangement of Forming Tools on Cross-slide

The cam-shaft driving belt on the machine for handling this work should be somewhat heavier and tighter than usual, although it will be found by experimenting that the pressure required to form the wire does not equal that often used in heavy cutting with cross-slide tools. Fig. 2 shows a front view of the cross-slide tool arrangement, looking from the turret, and Fig. 3 shows a plan view. In Fig. 3, the forming tool is shown at *A* and the die at *B*; and in Fig. 2 the die is shown at *B*, the forming tool being omitted. These special tools are made circular in shape and the material is tool steel, hardened and ground, while the toolposts are made of machine steel, and casehardened; if desired, the forming tool, as well as the die, could be made a unit with the toolpost. The special tools are clamped in position in the same way as the circular cutting tools, except that they are mounted outside the toolposts, which are made up for this purpose and are heavier than usual. In Fig. 3 the extra clamp *C* is shown and also the jack screw *D* which backs up the die. The same bolt that carries the forming tool also clamps the circular cut-off tool. A turret support for the work is shown at *F*. Figs. 2 and 3 show the spring plunger *G* which holds the work securely against the carrier *H*. This carrier has a lower extension (shown at *I*, Fig. 2) which, together with the turret support *F*, carries the work after it has been separated from the bar. It should be noticed that the face of the spring plunger *G* has a circular cut to receive the lower extension *I* on the carrier, the retaining screw being shown at *J*.

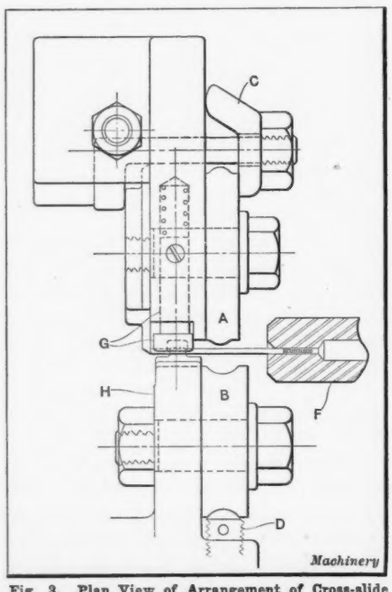

Fig. 3. Plan View of Arrangement of Cross-slide Tools shown in Fig. 2

To obtain the best results, the front and rear tools should be mounted on the same center as shown in Fig. 2. This does not affect the cut-off tool (which is usually mounted ¼ inch below center) because the diameter of the work is small. In operation, the piece is hollow-milled and threaded close to the chuck and then fed to the stop. The cut-off tool now operates, and at the same time the support *H* passes under the work and dwells there, and a little later the support *F* in the turret also supports the work, the hole in the support being chamfered for this purpose. Fig. 3 shows the support *F* as it advances; but when the wire is formed the support is in a forward position as close as clearance will allow. Just as the cut-off tool has separated the work from the bar, an additional forward movement compresses the springs which operate the plunger *G*, thus holding the work firmly against the carrier *H* so that when the bend occurs it is located 1 inch from the cutting-off end, all the draw being taken from the threaded end of the wire. Thus it is seen that the rear cross-slide has three distinct forward movements, *i. e.*, to cut off, clamp the work and form the bend. All the tools now withdraw simultaneously and the wire drops into the pan as usual. The order of operations is shown in the table and the arrangement of the turret tools in Fig. 4.

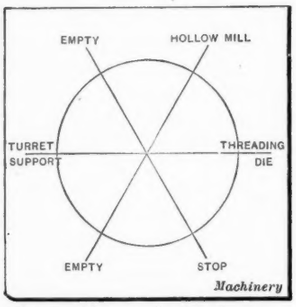

Fig. 4. Diagram showing Arrangement of Turret Tools

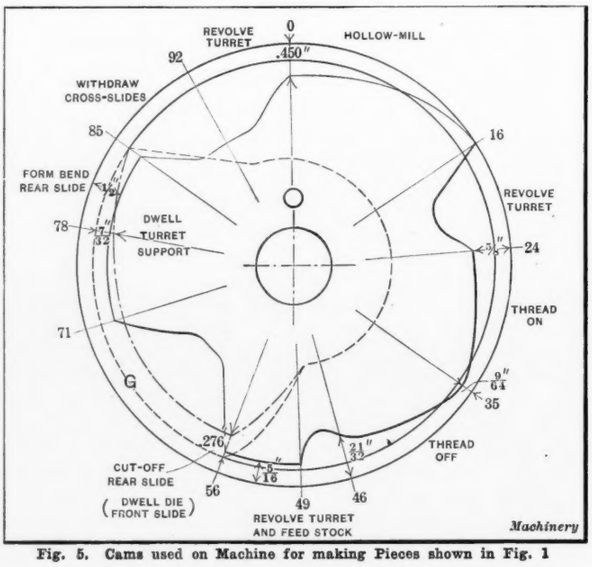

Fig. 5. Cams used on Machine for making Pieces shown in Fig. 1

The set of cams for this operation is shown in Fig. 5. The lead cam is illustrated by the full line, the front cross-slide cam by the dotted line, and the rear cross-slide cam by the dot and dash line. Attention should be called to the layout of the lead cam. It will be noted that, in this case, as the feeding of the stock follows directly after the revolving of the turret, 1 or 2 per cent of the cam surface is added to the usual amount given in the table. The front cross-slide cam from 56 to 85 on the cam circle is ground to be the same

TABLE GIVING ORDER OF OPERATIONS

	Revolutions at 1200 per Minute	Percentage of Cam Surface
Hollow mill 0.450 inch at 0.001 inch feed	45	16
Revolve turret	22	8
Thread on thirty threads	31	11
Thread off	31	11
Revolve turret and feed stock to stop	28	10
Cut off 0.058 inch at 0.0009 inch feed	62	22
Revolve turret twice while cutting off	(42)	15
Form bend	20	7
Withdraw cross-slides to clear	19	7
Revolve turret	(20)	8
Revolve turret	22	8
Total number of revolutions to make one piece	280	100

Machinery

radial distance from the center and thus give a steady dwell for the die. The turret support *F* takes hold of the wire at 71 on the cam circle and the wire is formed from 78 to 85. The space from 85 to 92 provides clearance so that the hollow-mill does not strike the other tools when the turret is revolved.

In conclusion it should be mentioned that the heavy No. 2 Brown & Sharpe die-holder was not used for cutting these fine threads; the much smaller No. 00 die-holder was used and was carried in a ⅝-inch drill extension which had a 1-inch shank. In comparing the expense and efficiency of the tool equipment just described the reader should take into consideration that the special tools would cost little more than the regular equipment and also that the regular punch-press operation would require a special operator, whereas more than one automatic may be operated by one man. Besides, it is always an advantage to have the least number of machines in operation on a piece of work and also to have the work completed in one department without extra cleaning, counting, and trucking.

* * *

PERKINS AUTOMATIC SCREW MACHINE

The automatic screw machine shown in Fig. 1 was designed by J. E. Perkins for the Winsted Hardware Mfg. Co. of Winsted, Conn., and this concern keeps several of these machines running on its work. The machine is intended for doing work that can be performed complete in three operations, namely: drilling or end-working, forming with the cross-slide, and forming and cutting off with the rear slide. The machine is extremely simple in construction and operation, and for work within its scope its first cost and operation are extremely low. The operation is entirely automatic, after the stock has been started. Fig. 2 is a close-range view of the tools at the point of action. It should be understood that the machine is not highly refined in its design, as only a few were to be built.

The stock bar is fed through the hollow spindle, as is usual in screw machine operations, and the bar and spindle are rotated by means of a belt on the spindle pulley. The working functions of the machine are all derived from a cam-shaft *A* which runs longitudinally beneath the bed. This cam-shaft is operated by a driving wheel *B* located on a shaft *C* at right angles to this cam-shaft, motion being transmitted by means of a worm and worm-wheel *D*. From this cam-shaft are actuated the operations of the turret slide *E* with the end-working tool, the front forming slide *F*, the rear forming slide *G*, and the stock-feeding mechanism. The turret slide is operated from a cam drum *H* on the extreme right end of the cam-shaft, which in conjunction with the post *I*, projecting downward from the turret slide, operates the drill, counterbore or end-forming tool, as the case may be. The front forming slide and the rear forming slide are both operated from opposite sides of a plate cam *J* on the cam-shaft near the center. These tools may be adjusted by set-screws at the ends of the operating levers. It should be especially noticed that the two forming slides are operated independently of each other; that is, the front forming slide operates on the rear forming slide, but is in no way governed by its movement. This means that there is a minimum of idle movements, and the space on the cam is not wasted. This slide construction may be best seen by referring to Fig. 2. Here the front forming slide may be seen at *F* carrying the tool *L*, and the rear slide at *G* carrying the tool *M*. The front slide is dovetailed into the rear slide, but retains its independent action. Thus, the front slide can be advanced at the same time as the rear slide if desired, or in fact any combination of the two movements may be secured and at varying speeds.

The operation of the stock-feeding mechanism is effected from the left-hand end of the cam-shaft. Here is a cam-drum and cam-lever that operates a plunger shaft parallel to the main spindle, and by means of yokes from this shaft the chuck is opened, the stock advanced and the chuck closed, using the Brown & Sharpe type of collet, in which the chuck is closed by a taper sleeve being forced on the outside of the taper on the collet, thus insuring positive operation. The gripping fingers for feeding the stock are within the pulley that operates the spindle.

The machine will handle bar stock up to ½ inch diameter, and the production is at the rate of from six to eight pieces per minute according to the nature of the work.

C. L. L.

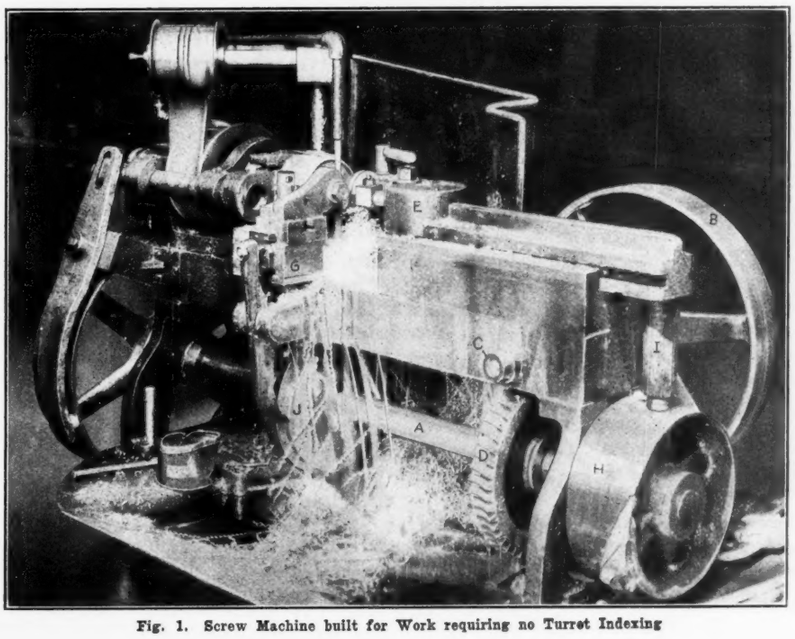

Fig. 1. Screw Machine built for Work requiring no Turret Indexing

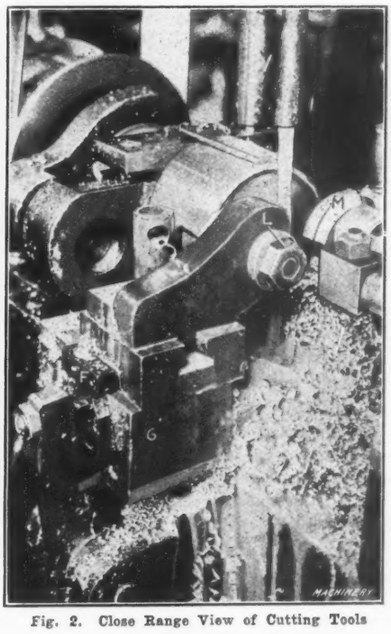

Fig. 2. Close Range View of Cutting Tools

Note Complete Protection afforded the Eyes and Orbits from the Front and Sides, also the Wide Unobstructed Vision

PROPER EYE PROTECTION

BY W. B. MC KIBBIN*

The inadequate protection or absolute non-protection of the eyes of grinding machine operators, blacksmiths, machinists, and the ladle men and chippers in foundries, is a form of criminal negligence that is entirely inexcusable. Authentic statistics are not obtainable but information from reliable sources shows that many thousands of avoidable eye accidents occur every year. The workman in many cases is as much to blame as his employer, or more, because he is willing to take a chance rather than insist upon having proper eye safeguards, which the employer would not dare to refuse him even if he wanted to.

Many workmen do not seem to realize that the full responsibility for the maintenance of their families rests directly upon their own shoulders. Such men are even unnecessarily careless at times and will risk antagonizing their employers by failing to use eye protectors that are provided for them. It is true that the wearing of special eye protectors is compulsory in some shops, but considering the numerous "Safety First" crusades, and the various "Employers Liability" and "Workmen's Compensation" laws, it is amazing how many thousands of workmen risk their eyesight every day when they could so easily secure the proper protection.

Infection

In the plants of one steel company, 250 men lost their eyes in one year by permitting fellow workmen to remove foreign substances from them. In some cases, the particle actually penetrates the coat of the eye-ball, and unless it is properly removed—especially if it is a particle of metal—the sight of both eyes is in danger through sympathetic inflammation, which is likely to cause permanent blindness. Sometimes infection results, causing dangerous ulcers which partially or wholly destroy the eyesight, and at times the entire eyeball. In this connection it should be mentioned that where more than one man uses the same eye-protectors, the danger of infection is serious.

Dangerous Workmen

A workman with defective eyesight or one using unsuitable goggles which impair his vision, is not only a menace to himself but to his fellow workmen, as a slight miscalculation on his part may affect the management of the machinery to such an extent that a serious accident may happen to him or to those working in his vicinity. The vision is often affected so slowly that the person is not aware of the fact until his eyesight is seriously impaired. This is particularly true in the case of operators of dry grinding machines. In operating such machines, small particles of metal become lodged in the cornea, and upon examination with a magnifying glass numerous scars will be found which dull the cornea and are very apt to seriously diminish the power of vision.

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Improper Eye Protectors

The use of improper eye protectors is probably worse than no protection at all, for in the event of an accident which results in breaking the glass, an injury suffered by the workman is likely to be increased rather than prevented through the so-called protectors. Eye protectors provided with glasses which are off color are likely to weaken the eyes of the wearer and should not be used. Glass combined with celluloid or gellatin is never clear and imperfections in the glass cannot be eliminated. As a result, distant objects seen through such goggles are distorted, and for this reason they should never be used. The use of goggles covered with wire gauze is also undesirable as it shuts out from 15 to 35 per cent of the illumination. If the mesh is woven from dark colored wire, the light is absorbed while a bright wire causes distracting reflections. Mica is very unsatisfactory for goggles, as it is not clear, it scratches easily and becomes opaque when bruised. Celluloid has the same faults as mica with the added objection that it is dangerous, owing to its low ignition point and its highly combustible character.

Practical Eye Protectors

Clear vision and the benefit of all the illumination provided in the shop is an absolute essential of an efficient eye protector. The lenses should be large and have the highest possible transparency; they should be absolutely clear and colorless. The lenses should be free from "waves"; perfectly ground on both sides and made of a tough, strong and perfectly annealed glass that is thick enough to withstand a heavy blow. At the same time, the frames should be so designed that if the glass is broken, the pieces will be held in the frame. If the wearer needs glasses to bring his vision up to normal efficiency, the lenses of the eye protector should be ground to comply with the oculist's prescription.

The protector should also be provided with substantial screens to shield the sides of the eyes. Another important point is to have the frames made of a non-rusting, non-tarnishing metal without any leather, velvet or similar material in the construction. When such materials are used, sterilizing cannot be easily done, and sterilizing is an absolute necessity if the same eye protectors have to be used by more than one man. In one factory, the use of proper eye protectors reduced the eye injuries from 6.5 per cent of the men employed in the year 1910 when protectors were not used, to 1.6 per cent of the men similarly employed in the year 1912 when eye protectors were in general use. These figures show a decrease in eye accidents of 75 per cent, and present an undeniable argument in favor of the universal use of effective eye protectors.

* * *

It is predicted by Dr. C. P. Steinmetz of the General Electric Co. that within ten years there will be one million moderate priced electric vehicles in operation. These cars will be sold at a cost not exceeding $500 to average a speed of 20 miles per hour.

CARE AND USE OF HOISTING ACCESSORIES*

WIRE ROPE, MANILA ROPE, HOOKS, CHAINS, ACCESSORIES, LUBRICATION OF WIRE ROPE, STRENGTH OF SLINGS

RELIABILITY is a requisite in the use of chain slings, rope slings and other hoisting accessories employed for attaching loads to cranes and hoists. Chain slings are in common use. They are flexible and lend themselves readily to most of the hitching operations met with in industrial work. Care must be taken, however, in the use of these slings, inasmuch as frequent strains slowly weaken the chain by crystallization, a condition which, though serious, is not readily visible. Weakness caused by surface wear or the slight opening of a single link is also likely to escape notice. Breakage of single links occurs often in cheap chains made of common iron or steel, insecurely welded; a flaw in any one link may drop the load. It is therefore obvious that a cheap common chain is entirely unsuited to overhead transportation of materials. Only the very best hand-made and tested wrought-iron chain should be used for this purpose. The extra cost is negligible when compared with the liability of accident through breakage.

Wire Rope

There is a growing tendency to use wire rope for slings. Undue wear is promptly shown by broken or worn wires on the surface, which gives warning that the rope is in an unsafe condition. A wire rope sling is also stronger than a chain sling of equal size and weight. Wire rope, however, should be of the best material. Crucible steel wire rope has greater strength than iron wire rope; plow steel rope is still stronger. By substituting the better grades of steel rope, much smaller, lighter, and more easily handled slings can be employed. Wire rope for general service is usually composed of six strands of wires wound about a hemp core to make the rope pliable and to provide a cushion to reduce internal friction of the wires. When used in proximity to heat, however, as when handling molten metal, wire rope slings provided with a soft iron core, even though the slings are less flexible, should be used. In such service a hemp center may be destroyed and the rope deformed.

Spliced ends are more dependable than clamped ends. Load strains which stretch the rope slightly reduce its diameter to a certain extent, and the ends are likely to slip through the clamps. Splices should always be made by experts. Small plants may not be properly equipped for splicing wire rope, in which case it is desirable to have this work done at wire rope factories, where it can be done well, and at small cost. It is often advisable to wrap the splice closely with soft wire, not to increase its strength, but to protect the hands of the workmen from protruding wire ends. Instead of splicing the ends, forged steel sockets with hooks, eyes or other fittings are frequently secured to the rope by spreading the wires in the socket and pouring zinc into it, between and around the wires. Sockets should also be attached by experts to insure secure connections. Wire rope manufacturers are equipped with special facilities for doing this work economically.

Manila Rope

Manila rope slings are desirable to wrap the load snugly or to avoid marring it. Manila rope, however, is much weaker than wire rope, wears easily, and cannot be utilized where it would be exposed to flame or to charring temperatures. It weakens if allowed to remain wet, and should therefore be promptly dried. Although the strands are easily cut if the rope is used for handling sharp-cornered loads, the frayed condition of the rope gives prompt warning of undue wear and weakness. If manila rope slings are to be employed, it will pay to buy the best long-fibered rope obtainable. The splices must be carefully made. Manila rope should never be looped with wire rope, as the smaller wire rope will cut through the strands of the soft manila rope.

Accessories

Hooks, eyebolts, clamping devices and similar parts attached to slings deserve equal attention in respect to their safety. Forged hooks of approved design and material can readily be purchased from reliable manufacturers who specialize on this class of work. This is also true in regard to rings for slings, eyebolts, turnbuckles, shackles and other important hoisting accessories. If cast steel hooks are used they should be well annealed and of larger proportions; but in any case, cast steel hooks are not so dependable as forged hooks. For severe service, hooks made of laminated steel plate, securely riveted, have proved satisfactory. Chain hooks and similar parts should bend slowly if overloaded, and thus give warning of their unsafe condition. They should therefore be well annealed, and never tempered or hardened. A brittle part will snap outright and drop the load.

It is clear that hoisting appliances should be suitably designed and well made, but it is fully as important that their use be carefully and intelligently supervised and their original strength maintained. There is evidently not so much danger when handling unusually heavy loads, for such operations are, as a rule, under the care of the most capable men, who anticipate the extra risk by careful preparation. Hoisting accidents more frequently occur when ordinary loads are being handled by ordinary men, and when the usual facilities are either too light, wrongly employed, or weakened by wear or use.

Information Relating to Strength of Hoisting Appliances

It is of first importance that men using hoisting accessories should know the strength of them. It is not sufficient to know the size, unless the grade is also known. While 1500 pounds may be a safe load for a single sling made of ⅜-inch *plow steel* wire rope, such a load would be excessive for an *iron* wire rope sling of the same diameter. This wide range of strength also occurs in different grades of chains and other accessories, but the difference is not readily apparent. It is therefore dangerous to provide several grades of slings and hooks in the same shop. Furthermore, a new workman, fresh from a shop in which only the strongest slings and hooks are employed, is likely to assume that the appliances in the new shop are equally strong. The safety of workmen therefore requires that all slings of equal size should be of equal strength, and of *maximum* strength, and that other details are proportionately strong.

While workmen who are accustomed to the use of slings acquire, by long experience, a valuable knowledge of the strength of chains and ropes under varying conditions, this should not be left to guess-work. It is advisable to post in conspicuous places in the shop, especially at the chain racks, and, where possible, at the point of operation of each crane, a chart showing the loads which can be safely supported by slings of various sizes, whether used normally or in a manner that decreases their lifting capacity. From a study of satisfactory crane practice in various large plants, a chart of safe loads has been compiled, which is published herewith. The loads recommended in this chart are more conservative than those usually specified, because it is intended to recognize the possible existence of slight, unobserved weaknesses in slings and the liability of excessive strains which may be applied to slings through misjudgment or accident.

It will be noted that the safe loads shown upon this chart are based upon the use of 6 by 19 or 6 by 37 plow steel wire rope; the best grade of wrought-iron, hand-made chain; and four strand long fiber manila rope. Here again the advantage of standardizing the grades of materials used for hoisting purposes is apparent; otherwise the chart would be misleading. The chart is based on the supposition that the original strength of hoisting appliances is practically maintained. The extraordinary hazards of overhead transportation of materials demand this. Hence it is becoming more and more the practice to follow a plan that provides for regular inspection and care of all hoisting accessories in the plant, to guard against deterioration.

Inspection

First of all, each sling should be stamped or tagged with

* From Bulletin No. 13 of the National Founders' Association Committee on Safety and Sanitation.

an identification number that tallies with an office list, which should describe the slings and state their grade, size, date of purchase, and other useful information. At regular intervals, the person delegated to inspect slings should locate each one, inspect its condition, lay defective ones aside for repairs or for the scrap heap, and note upon his list a short report of his findings. The frequency of inspection must be governed by frequency of use. In shops where slings are seldom used, monthly inspection may be adequate, but it is more usual to inspect all hoisting accessories once a week. It is important, too, that the inspection work should be regularly done, at stated intervals, else it may drift into a condition of neglect. Such inspections require only a short time, but they bring to light dangerous weakening of the strands of manila and wire

TABLE OF SAFE LOADS IN POUNDS FOR ROPES AND CHAINS

Prepared by National Founders' Association. When handling molten metal, wire ropes and chains should be 25 per cent stronger than indicated in table below.

NOTE. The safe loads in table are for each *single* rope or chain. When used double or in other multiples the loads may be increased proportionately.		When used Straight	When used at 60-degree Angle	When used at 45-degree Angle	When used at 30-degree Angle
	Diameter of Rope				
	Inch				
PLOW STEEL WIRE ROPE	3/8	1,500	1,275	1,050	750
	1/2	2,400	2,050	1,700	1,200
	5/8	4,000	3,400	2,800	2,000
(6 strands of 19 or 37 wires)	3/4	6,000	5,100	4,200	3,000
	7/8	8,000	6,800	5,600	4,000
	1	10,000	8,500	7,000	5,000
If crucible steel rope is used reduce loads one-fifth.	1 1/8	13,000	11,000	9,000	6,500
	1 1/4	16,000	13,500	11,000	8,000
	1 3/8	19,000	16,000	13,000	9,500
	1 1/2	22,000	19,000	16,000	11,000
	Diameter of Iron				
	Inch				
CRANE CHAIN	1/2	600	500	425	300
	5/8	1,200	1,025	850	600
	3/4	2,400	2,050	1,700	1,200
(Best Grade of Wrought Iron, Hand-made, Tested, Short Link Chain.)	7/8	4,000	3,400	2,800	2,000
	1	5,500	4,700	3,900	2,750
	1 1/8	7,500	6,400	5,200	3,700
	1 1/4	9,500	8,000	6,600	4,700
	1 3/8	12,000	10,200	8,400	6,000
	1 1/2	15,000	12,750	10,500	7,500
	1 3/4	22,000	19,000	16,000	11,000
	Diameter of Rope	Circum. of Rope			
	Inches	Inches			
MANILA ROPE	3/8	1	120	100	85	60
	1/2	1 1/2	250	210	175	125
	5/8	2	360	300	250	180
	3/4	2 1/4	520	440	360	260
	7/8	2 3/4	620	520	420	300
	1	3	750	625	525	375
(Best Long Fiber Grade.)	1 1/8	3 1/2	1,000	850	700	500
	1 1/4	3 3/4	1,200	1,025	850	600
	1 1/2	4 1/2	1,600	1,350	1,100	800
	1 3/4	5 1/2	2,100	1,800	1,500	1,050
	2	6	2,800	2,400	2,000	1,400
	2 1/2	7 1/2	4,000	3,400	2,800	2,000
	3	9	6,000	5,100	4,200	3,000

Machinery

ropes, worn or broken links in chains, and similar injuries to hooks, rings, eyebolts and other parts.

Annealing Chains and Hooks

When crane chains, hooks and similar parts are weakened by crystallization, their original strength can be practically restored by giving them a heat-treatment usually termed annealing. As a crystallized condition, however, is not readily apparent, the only reliable way to maintain their strength is to treat such parts frequently enough to forestall the risk of hidden weakness. Slings and hooks that are frequently used may require such treatment every two months; in rare cases one treatment per year is sufficient. It is the usual practice to heat these accessories to a temperature of about 525 degrees C. (980 degrees F.), dull red, or about the temperature of an open wood fire, and cool them in the ashes or in the open air. Actual annealing is not accomplished at this temperature, neither is it the purpose to anneal the parts, but rather to heat them sufficiently to remove structural strains without softening the metal. An unduly slow process of cooling tends to make the metal too soft to insure good wearing surfaces.

Lubrication of Wire Ropes

Wire rope suffers from rust, stiffness, and from excessive friction of the wires, internally and externally, if not properly and regularly lubricated. The lubricating agent should be of such a nature that it will penetrate through the rope, as well as cling to its outside surface. This is especially important on ropes exposed to moisture. A mixture of petrolatum, graphite, and crude oil has proved useful. The right lubricant can also be secured from wire rope manufacturers or their agents.

General Safeguards

Defective hoisting accessories, if allowed to remain in the shop, are likely to be used by mistake for perfect ones, with serious results. Such parts should immediately be removed from the shop; if permanently discarded, they should be so damaged as to prevent workmen from using them by mistake. It is advisable to provide extra sets of slings and other accessories; otherwise there may be considerable hesitation in sending out much needed parts for repairs until they become too weak and cause injury to workmen or material.

Workmen sometimes strike heavy blows upon hooks or chains to force them into position on the load. Workmen should be carefully cautioned against such practice. It is also common to insert nails and slivers between the links in multi-part slings to equalize the length of each part; cast-iron pieces should never be used for this purpose, as they will break when the load is applied, and cause a sudden jar which may break or injure the chain.

It is important to avoid kinks in slings. Kinks permanently injure a rope sling by acutely bending the wires. Kinks in a chain sling often straighten out suddenly when the load is applied, and an excessive stress is imparted to the sling and the chain is broken.

Employes and supervisors, by following these suggestions, will make hoisting operations quite safe; yet remember: Personal caution is the greatest safeguard, after all.

* * *

GERMAN PATENTS IN GREAT BRITAIN

The confusion into which the war has thrown the patent system in Great Britain is being cleared up by the working of an act of Parliament which extends power to the Board of Trade to suspend any patent, license or registered trademark granted to any subject of a state at war with Great Britain. Permission to manufacture such articles is granted upon application, and upon the payment of a fee fixed by the Board of Trade, after a hearing at the patent office. This fee or royalty is devoted to a fund, the disposition of which depends upon the treatment British holders of patents will receive in hostile countries.

Taking into consideration both patents and trademarks, Germany and England are about on an equal footing in this matter, there being about as many German holders of patents and trademarks in England as there are British holders in Germany. The patent office in London has, at the present time, as many applications for suspensions of German patents as its machinery for fixing royalties can take care of.

* * *

Bulletin 66 recently issued by the Bureau of Railway Economics, Washington, D. C., gives some valuable statistics of railways for the years 1900-1912, inclusive. The statistics show the increase of railway mileage, equipment and number of employes and the rising rates of wages and other operating expenses. In 1900, the total number of machinists employed on the railways of the United States was 32,831; the number of carpenters was 46,666; and other shop men, 114,773. In 1912, the figures were 57,507, 70,817 and 249,429 for the respective classes. In 1900, the average daily wage paid to machinists was $2.30; carpenters, $2.04 and other shop men, $1.73. In 1912 the rates had risen to $3.20 for machinists, $2.55 for carpenters and $2.24 for other shop men.

TOOLS FOR MAKING A DOUBLE-PRONGED RIVET

To make double-pronged rivets such as shown in Fig. 1 automatically in a punch-press at the rate of over one hundred per minute without requiring the attention of an operator is a job that requires an exceptionally good set of press tools. The rivet is made from German silver wire 0.060 inch diameter. The prongs are each one-eighth inch long and it will be noticed that the bridge that connects them is upset or flattened out, but the prongs are left round. The line illustration Fig. 1 shows the steps taken in producing the rivet; this is represented four times actual size. First, the blank is cut off ⅜ inch long, then it is bent U-shaped, and finally, with the prongs confined, the bridge is flattened and the piece ejected. While these operations might be performed upon a four-slide wire forming machine, it is doubtful if, in so doing, any advantage would be secured over the method of press-working illustrated below.

Figs. 2 and 3 show the tools in action in a small press; Fig. 2 illustrates the tools from the front and right, and Fig. 3

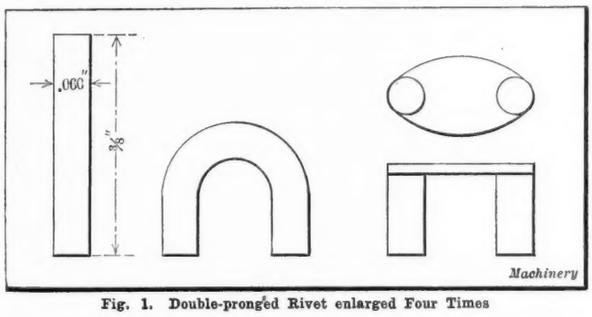

Fig. 1. Double-pronged Rivet enlarged Four Times

shows them from the front and left. Moreover, in Fig. 2 the punch is in the upper position, while in Fig. 3 the punch is nearing the downward end of its stroke, illustrating another phase of the operations. In connection with the line illustration Fig. 4, the operation of the tools may be followed.

The wire enters the tools from the front through a bushing-block *A* whose purpose it is to free the wire of kinks and leave it relatively straight for the feed rolls *B*. These feed rolls are kept in spring tension and are geared together and operated from an eccentric *C* and rod *D*, actuated from the crankshaft of the press. The movement of the rod is permanently set to give the feed the exact amount of wire that is required. After the wire enters the tools, the operations are cutting off, carrying over, flattening and ejecting.

The cutting off is accomplished by a shear blade located on lever *E* that is fulcrumed on stud *F*. This lever is pulled up by bar *G* that is attached to the ram of the press. As the wire passes through a cut-off bushing (see Fig. 4) it is confined while the shear comes up against it and severs it. An aligning block *X*, on lever *E*, acts as a back-stop for the cutting-off bushing while the work is being sheared. Immediately ahead of the cutting-off shear comes the bending tool

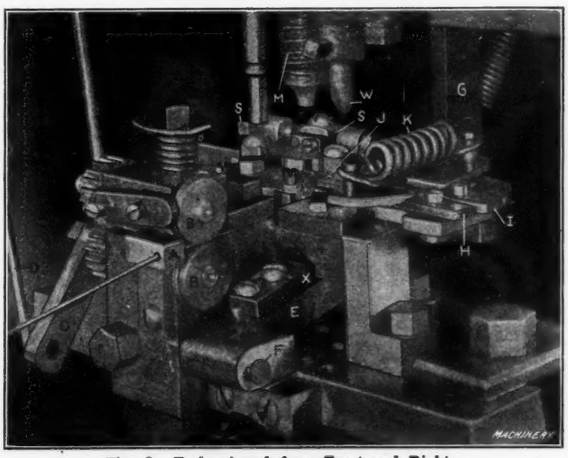

Fig. 2. Tools viewed from Front and Right

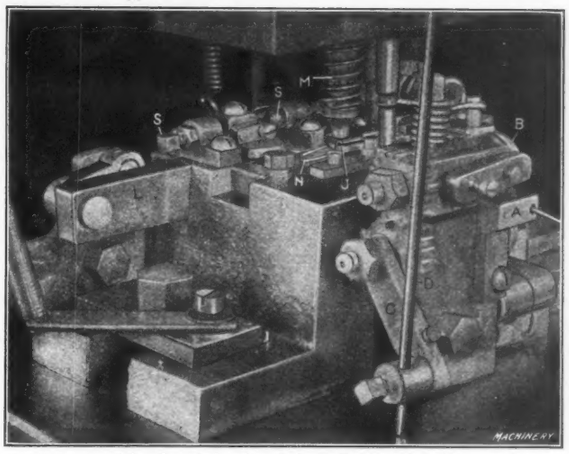

Fig. 3. Tools viewed from Front and Left

that forms the wire by forcing it up through the die. These tools are concealed in Figs. 2 and 3, but may be seen in Fig. 4. Continued raising of lever *E* causes the bending tool to raise the wire above the die and force it between two spring fingers whose back ends are shown at *H* and *I* in Fig. 2. Here also the loop of wire shows at *J*. The fingers are kept at the right tension by spring *K*.

The mechanism of which these spring fingers are a part is for transferring the wire loop to the die where the bridge is flattened. This mechanism is mounted on a slide that can best be seen in Fig. 3 at *L* in the rear of the die. Through a

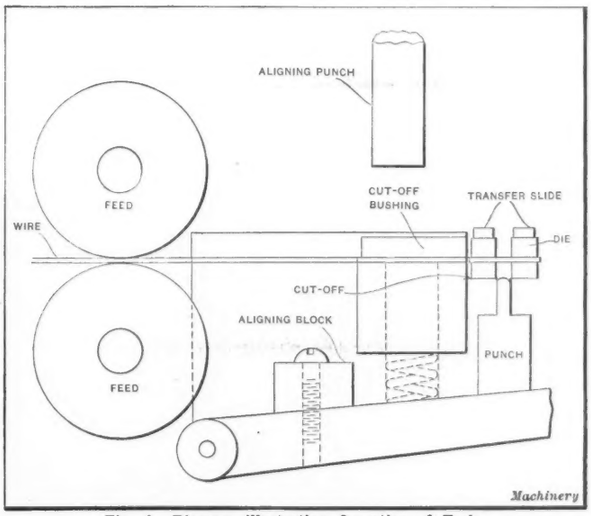

Fig. 4. Diagram illustrating Operation of Tools

set of toggles worked from the left end of the crankshaft, the slide is reciprocated and the work is thus transferred to the heading position. It is essential that the travel of the transfer slide be within close limits and these limits are arbitrarily determined by adjusting set-screws *S* which act as stops.

The heading punch is made in two parts, kept separated by a spiral spring *M* and thus permits the descending punch to push the prongs into the holes in the die before the heading takes place. As soon as the tip of the punch "bottoms" on the base, the bridge of the rivet is flattened. A wedge on the punch *W* separates the spring fingers *H* and *I* after the rivet has reached the heading position. This gives the flattening punch room to work.

The rivet is now completed except for ejection. This is accomplished by a knock-out plate operated also from the crankshaft. Two pins on the knock-out work upward through the two holes in the flattening die and push out the rivet. As soon as it is clear of the die, a spring wire finger *N* "kicks" the rivet to one side.

These tools were made by J. H. Pilkington, manufacturer of wire and sheet metal work, of Waterbury, Conn., through whose courtesy the photographs and description are reproduced.

C. L. L.

MAKING AERO MOTOR PISTONS*

TOOL EQUIPMENT USED ON CLEVELAND AUTOMATICS FOR COMPLETELY MACHINING GNOME AERO MOTOR PISTONS

BY DOUGLAS T. HAMILTON†

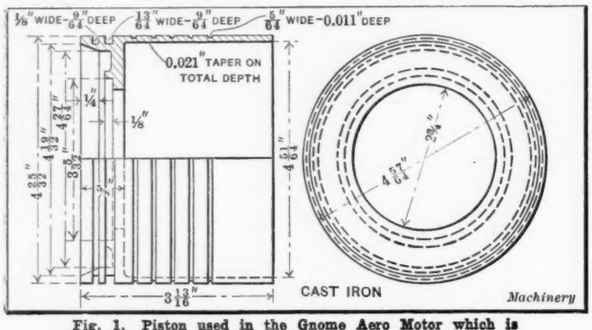

Fig. 1. Piston used in the Gnome Aero Motor which is machined complete on a Cleveland 2¼-inch Semi-automatic Machine

THE pistons used in an aero motor are made from iron castings, and as they must be very light, the walls are made extremely thin. The particular piston used in the Gnome aero motor is shown in Fig. 1 and it will be seen that the wall at the minimum thickness is only 0.0625 inch thick. The interior diameter of the piston is turned taper about 0.010 inch to the inch, which makes machining still more difficult, but this piston is finished complete in three operations, the first series being illustrated in Fig. 2 and the set-up for the second series in Fig. 3.

Tooling Equipment for the First Series of Operations

The machining operations on the aero motor piston are accomplished in a Cleveland 2¼-inch semi-automatic machine equipped with double cross-slides, which, for the first series of operations, is fitted up with a special three-jaw chuck. Fig. 4 shows how the work is held for the first series of operations and also illustrates the first two tools which are held in the turret at work. The first tool to come into operation is a rough-turning tool *A*, which is an overhanging tool and carries two cutters *a* and *b*. Cutter *a* rough-turns the external diameter and tool *b* reduces the end of the work for the next roughing cut. While these tools are at work, another tool-holder *B* held in the turret brings boring, facing and chamfering tools *c*, *d* and *e* into action. Tool *c* rough-bores the smallest internal diameter, tool *d* roughs out a small seat in the head of the piston and tool *e* rough-recesses and faces the head of the piston.

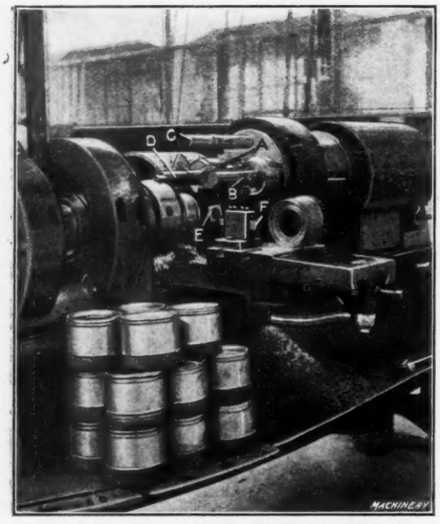

Fig. 2. Set-up on the Cleveland Automatic for performing the First Series of Machining Operations on the Gnome Aero Motor Piston

Upon the completion of these operations, the turret is indexed and boring tool *C* comes into action; this carries two tools *f* and *g*, which take rough- and finish-boring cuts from the smallest internal diameter of the piston. The leaders of rough-boring tools *B* and *C* are guided by a bushing *h* fitted into the nose of the spindle.

The turret is again indexed, and finish-recessing and chamfering tool-holder *D*, shown in Fig. 5, comes into action. This holder carries a tool *i* which finish-recesses the head of the piston casting, and is guided by the bushing *h* in the nose of the spindle. While tool *i* is at work, the other cutter *a* held in the tool *A* shown in Fig. 4, takes a second roughing cut from the outside diameter. The turret is again indexed, and reamer *k* comes into action. This reamer is held in the floating holder *E* as illustrated in Fig. 5, and finishes the smallest internal diameter to the correct size. While the reamer is at work, the roughing piston-ring grooving tools *l* held in holder *F* on the front cross-slide are also in action, roughing out the two piston-ring grooves in the head of the piston casting. This finishes the first series of operations on the piston.

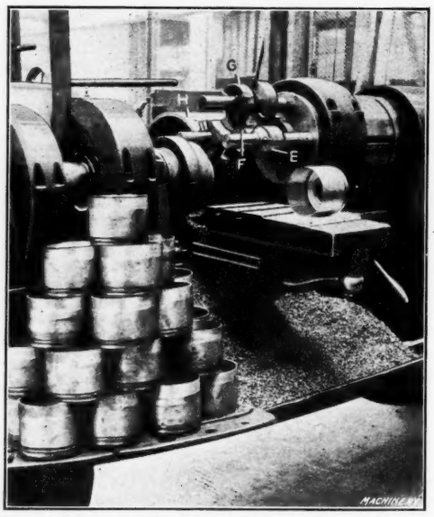

Fig. 3. Set-up for the Second Series of Operations on the Cleveland Automatic

Tooling Equipment for the Second Series of Operations

The machine is shown tooled up for the second series of operations in Fig. 3. For these operations a special work-holding chuck, as shown in Fig. 6, is used. This chuck comprises a special nose *A* screwed onto the nose of the work-spindle. Carried on this nose and free to slide on it, but prevented from turning by a set-screw, is a cap *B* which is acted upon by a nut *C*, the latter being threaded to the nose *A* and the cap *B*. The work is held in a special tapered chuck, comprising six segments, taper-turned on their external diameter, and located in their correct relative positions by pins that are held together by a flat spring retainer not shown. The action of this tapered chuck is to come down evenly on the work when the cap *B* is drawn in by collar nut *C*.

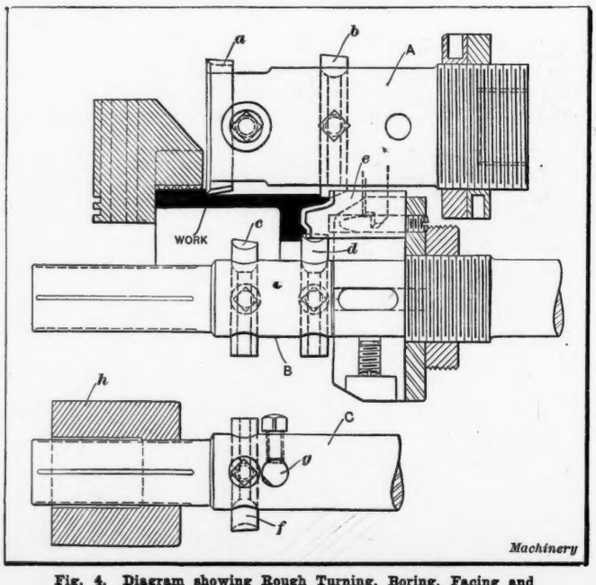

Fig. 4. Diagram showing Rough Turning, Boring, Facing and Counterboring Tools used for performing First Series of Operations

* For articles on screw machine work previously published, see MACHINERY, November, 1914, "Examples of Screw Machine Set-ups," and articles there referred to.

† Associate Editor of MACHINERY.

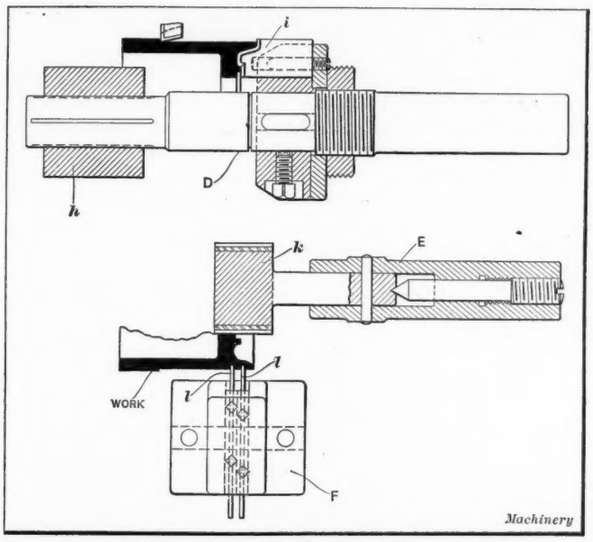

Fig. 5. Diagram showing Finish Counterboring and Facing, Finish Reaming and Rough Piston Groove Turning Tools held in the Turret and on the Cross-slide for the First Series of Operations

The first cut in the second series of operations is performed by tool-holder *E* (Fig. 6) held in the turret and carrying a single cutting tool *a*, which takes a rough-boring cut from the internal diameter. The tool-holder is provided with a pilot which fits in the bushing *b* in the nose of the spindle. This bushing serves the additional function of locating the work from the previously reamed hole in the piston. At the

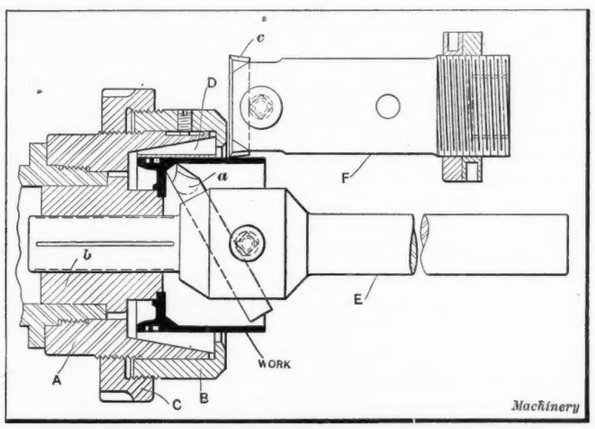

Fig. 6. Diagram showing Rough Turning Tool and Rough Boring Tool for the First Series of Operations in the Second-operation Set-up. This View also shows an Interesting Type of Chuck used for holding the Work

same time that the rough-boring tool *a* is working, an overhanging attachment *F*, screwed into the central shaft hole in the turret, carries a cutting tool *c* that finishes roughing the external diameter that was held in the chuck in the first operation. After these tools have completed their cuts, the turret is again indexed, bringing the combination rough-bottoming and end-facing tool-holder *G*, shown in the upper part of Fig. 7 into operation. This tool-holder which is held in the turret carries two cutter-heads *d* and *e*. Cutter-head *d* carries a rough-bottoming cutter *f* which is serrated on its face to break up the chips and reduce the cutting pressure. The end of the casting is faced by means of a cutter *g* held in head *e*.

Upon the completion of the rough-bottoming and end-facing operations the turret is again indexed and the finish-bottoming and end-facing tool-holder *H* comes into operation. This tool-holder also carries two cutter-heads *h* and *i* holding cutters *j* and *k*. Cutter *j* is a finish-bottom facing tool and is held in the head *h* by means of a tapered wedge as illustrated. Cutter *k* is a finish end-facing tool and is also held in place by a tapered wedge. While these two cutters are at work, a cutter held in the overhanging attachment shown in Fig. 6 takes a final cut from the external diameter of the piston—finishing that portion of the piston that was held in the chuck in the first operation. The size of the outside diameter after the second-operation turning tools have done their work is 4.9607 inches; the inside diameter after the first roughing cut is 4.7245 inches; and the inside diameter after the second cut is 4.7639 inches.

Tooling Equipment for the Third Series of Operations

For the third series of operations, the machine is equipped with an entirely different type of work-holding device, as shown in Fig. 8. This comprises a hood *A* which is screwed onto the nose of the spindle, and which is bored out to fit a clamping rod *B*. The clamping rod goes completely through

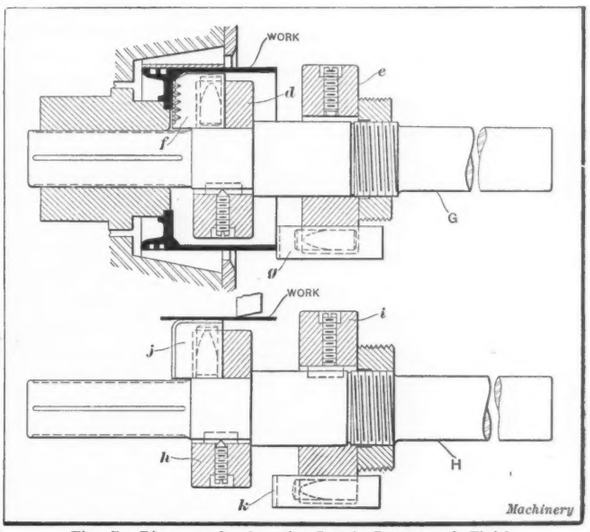

Fig. 7. Diagram showing the Rough Facing and Finish Facing Tools held in the Turret for bottoming and facing the End of the Piston

the work-spindle and has on its rear end a handwheel *C* which is used for clamping the work. In order to hold the work tight and rigid, an interesting clamping nut is used which forms a sort of differential screw. The external diameter of the hub of the handwheel *C* is threaded with a fine pitch thread which fits in a similarly shaped thread in the special nut *D*. The clamping bolt *B* is provided with a coarser pitch thread, and is made to travel with the nut *D* by means of a key, so that in tightening up the work both the threads on the clamping bolt and the thread in the nut *D* work in unison, and comparatively slight twisting action on the handwheel holds the work extremely rigid.

The clamping nut *D* is prevented from turning in the spindle by means of a set-screw as illustrated. The front end or head of the clamping bolt is "slabbed" and the clamping washer *E* is provided with a slot to facilitate the re-

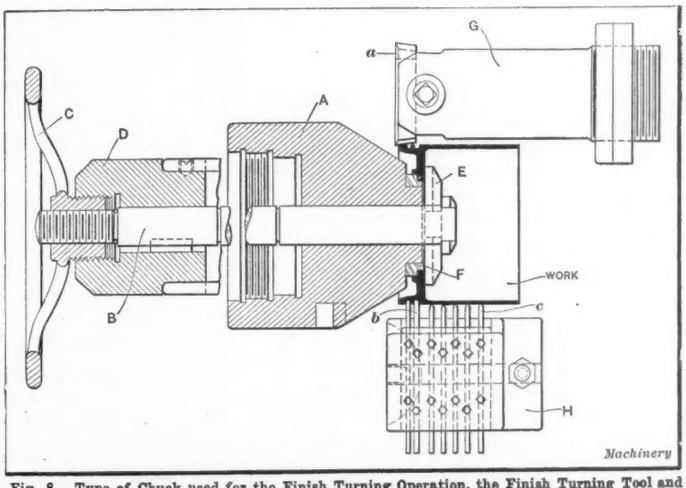

Fig. 8. Type of Chuck used for the Finish Turning Operation, the Finish Turning Tool and the Finish Piston Ring and Oil Grooving Tools, the Latter being held on the Cross-slide

moval of the work. The work is held on a machine steel seat *F*, fitted to the nose of hood *A* which fits into the two previously reamed and bored internal diameters of the piston.

The first operation is to finish-turn the external diameter to the required dimension—4¾ inches, which is done with an overhanging turning attachment *G*, Fig. 8, held in the same manner as holder *F*, Fig. 6, and carrying a single point cutting tool *a*. While this tool is working, a gang of tools held in holder *H* is brought in from the front cross-slide. These tools comprise two finishing tools *b* for the piston ring grooves, and five tools *c* for cutting the oil grooves in the external diameter of the piston. Upon the completion of these operations, the turret is indexed and the final cut is taken from the internal diameter.

The taper-turning attachment is illustrated separately in Fig. 9, and comprises a tool-holder *A* and a cross-slide guide holder *B* fastened to the rear cross-slide. The taper-turning tool acts in the following manner: As the turret advances carrying the taper-turning tool-holder *A*, the rear cross-slide also advances to the required point and then remains stationary while the turret continues in its forward movement. Upon the advance of the turret, pin *a* comes in contact with the guide *b*. This has the action of forcing in the tool-holder *c*, which is held outward against the stop-pin *d* by means of a coil spring *e*. This spring, of course, has a constant action and keeps the pin *a* always in contact with the guide *b*.

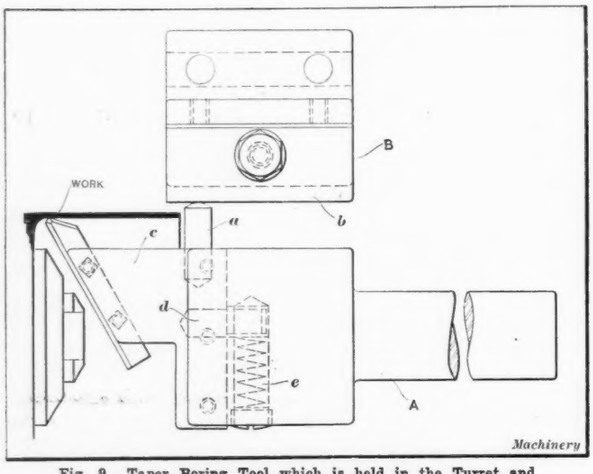

Fig. 9. Taper Boring Tool which is held in the Turret and operated from the Cross-slide for machining the Inside of the Piston. This is accomplished in the Third Operation. The Tools in Figs. 8 and 9 operate simultaneously

The tool-holder *c* slides in a dovetailed groove in the front face of the main body of the holder and is provided with an adjustable gib to take care of any slack or wear in the slide. The taper turning of the inside diameter completes the series of operations on the Gnome aero motor piston, and produces it complete at the rate of seventeen pistons per day of ten hours, the machining time being thirty-five minutes.

* * *

An interesting itemized statement of the cost of operating taxicabs in Stockholm, Sweden, is given in *Teknisk Tidskrift*. While some of the items will differ in this country on account of the lower cost of gasoline and the higher cost of wages here, the information is of considerable value. It is assumed that the cab is in actual use for three hundred and ten days and that it covers a hundred miles a day.

Gasoline.....2450 gallons at 26 cents per gallon,	$637.00
Tires	540.00
Wages	800.00
Garage	100.00
Repairs	230.00
Insurance	80.00
Taxes and Miscellaneous Expenses	27.00
Interest and Sinking Fund, 23.6 per cent on the original investment of $2850	672.60
Six per cent additional interest on investment for general expenses	171.00
	$3257.60

This gives the cost of operating a taxicab, including overhead charges, as equal to 10.5 cents per mile.

ADJUSTABLE AND MULTI-CUTTING TURNING TOOLS

BY FRANK H. MAYOH*

By way of comment on the article "Adjustable and Multi-cutting Turning Tools" by Albert A. Dowd, published in the February number of MACHINERY, I am inclined to ask if turning the outside of plain bushings is a practical turret lathe job. From Mr. Dowd's illustration Fig. 4, and the description presented in this connection, it appears that plain bushings of various sizes are mounted on expanding arbors held in a collet in the turret lathe spindle, while they are turned by a tool carried by a slide mounted on the turret. This slide looks somewhat like an engine lathe cross-slide set up in an unusual position. From a practical point of view—and according to what the writer believes to be commercial practice in the manufacture of bushings—the method illustrated in Fig. 1 of this article is far superior. An engine lathe is used and does not require any special rigging up except for the arbor.

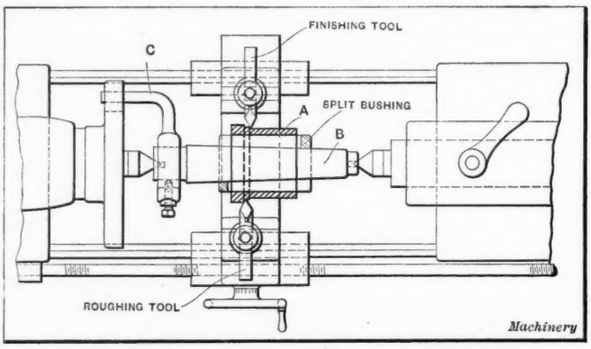

Fig. 1. Method of machining Bushings on an Engine Lathe

The work to be machined is shown at *A*, and the arbor *B* on which it is mounted may be bought in standard sizes at a relatively small cost. A suitable driving dog *C* will usually be found in any shop, and the same statement applies to an engine lathe with two centers. A further advantage of this method is that an engine lathe is a cheaper machine than a turret lathe. To machine the bushings, we take the arbor with the dog on it out of the lathe, put the work on the arbor and drive up the expanding bushing to hold the work in place. Now, placing the arbor in the lathe, we turn the work with the tools on the cross-slide, the front tool doing the roughing, and the rear tool the finishing at the same time by being set slightly behind the roughing tool in the manner shown.

Summing up the two methods of machining, we find, on one hand, a special arbor, a collet for holding it, and a special slide to go on the turret for turning, all of which would probably cost about $100. For machining the bushings on the engine lathe, all we have to provide is a special arbor costing about $10. This method will certainly produce as good work as could be turned out on the turret lathe, if not better, as the work is rigidly supported between centers, while the unique equipment described by Mr. Dowd has the end where the turning is being done unsupported. Taken on the whole, the turret lathe outfit would be a poor bargain if placed side by side with an engine lathe as described.

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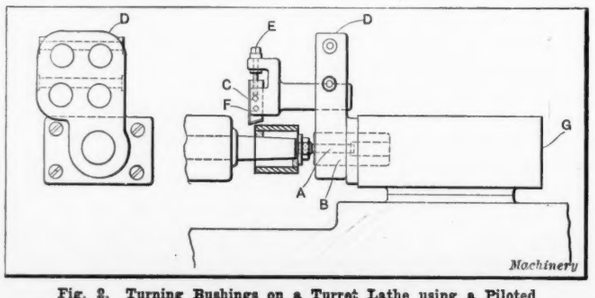

Fig. 2. Turning Bushings on a Turret Lathe using a Piloted Work Arbor

Now while it is not practical to use a turret lathe for this class of work, I believe a much more satisfactory method of machining this bushing on the turret lathe would be as illustrated in Fig. 2, where the arbor is of similar construction to the previous one and is held in a collet, but has, in addition, a pilot *A* on the end, which is a running fit in the bushing *B* held in the turret hole and ties the turret and arbor rigidly together for bracing. The turning is done by a bar and cutter *C* held in a tool-holder *D* which has four holes in it to take the bars while turning different diameters. The construction is a standard one by some makers and is capable of being adapted to a much larger range of work than the slide shown by Mr. Dowd, besides being cheaper. Adjustment of the blade in this bar is obtained by the screw *E*, while the cutters are bound by the screws *F*. Another set of similar tools may be placed on the turret face No. 3 at *G* if two cuts are required, and the tool-holders connected for bracing.

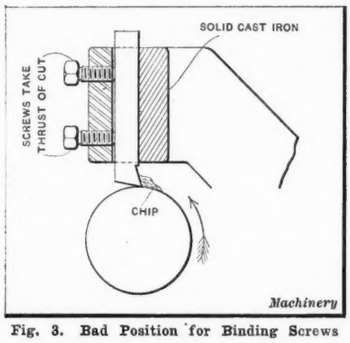

Fig. 3. Bad Position for Binding Screws

Another condition worth mentioning is shown by Fig. 3 in the February number. The screws which are shown binding on the back side of the cutters opposite the cutting surface must take the thrust of the cut as indicated by the arrow in Fig. 3 of this article; this condition is also shown in Mr. Dowd's illustration Fig. 7. A better construction would be to place the screws and plate for holding them on the opposite side and have the solid cast-iron tool-holder behind the tools for bracing, which would be much more substantial.

Having tooled up a machine for handling work similar to that shown in Fig. 6 of Mr. Dowd's article, it appears to me that while the method of piloting shown is all right with the combination of tools illustrated, were this job carried out and an attempt made to use similar tools throughout, the work produced would not be very accurate, because the pilot comes above the work and offers no support for the boring tools. To eliminate this I would tool this job up as shown in Fig. 4, where the operations would be: spot the hole with the tool *A* on the first turret face; drill and turn with the combination tool *B* on the second turret face, allowing the drill to follow in the hole spotted; as the drill is part way into the hole as shown by *X* before the turning tools commence to cut, it will help to steady them. Next, on the third turret face, place a boring-bar *C* and turning tools similar to those used with the drill. These are piloted into a bushing in the center of the chuck, thus tying all of the tools in this combination to the spindle, which insures the best possible degree of accuracy and cheapens the tool equipment by eliminating a pilot bracket and pilot bar, as these can be incorporated in the boring-bar and chuck.

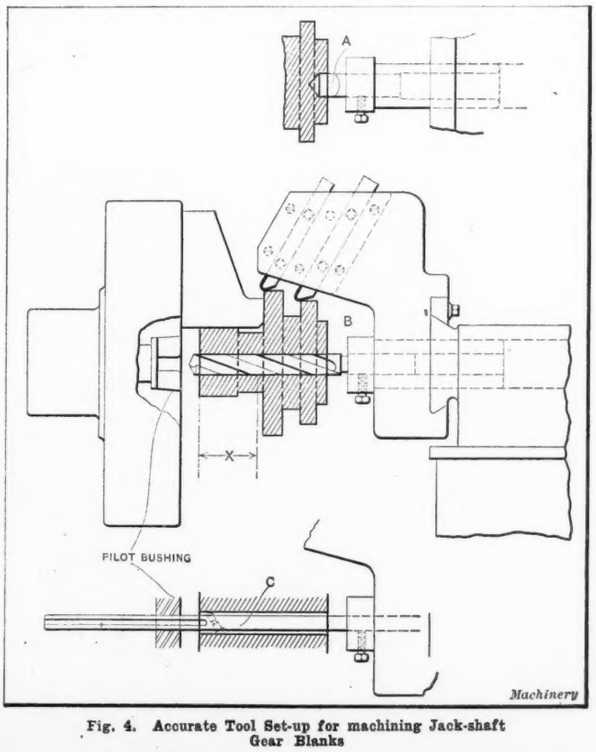

Fig. 4. Accurate Tool Set-up for machining Jack-shaft Gear Blanks

A comparison between my illustration Fig. 5 and Mr. Dowd's Fig. 9, will bring out an interesting point, as it shows a condition which is purely a matter of saving in manufacture. By mounting the pilot bar in the bracket on the headstock, I eliminate the necessity for cutting out the pilot bar at *K*, as referred to in the previous article, and I save one bar, as the bar can now pilot into a bushing in the roller back-rest on both roughing and finishing cuts; this also eliminates having a long bar extending way out when the turret swings. Mr. Dowd's Fig. 10 is another case where one pilot would do the work of two. I might add that were pilot brackets placed in the same position on the headstock in all cases, which does not appear to have been the case, they would be interchangeable and the same pilot bars could be used for almost all combinations of tools. Another point which suggests itself on this tool is that if the slide which carries the cutter were placed on the opposite side of the bracket, the thrust of the cut would come against the seat of the slide and not against the dovetail and gib, which would be a more substantial design.

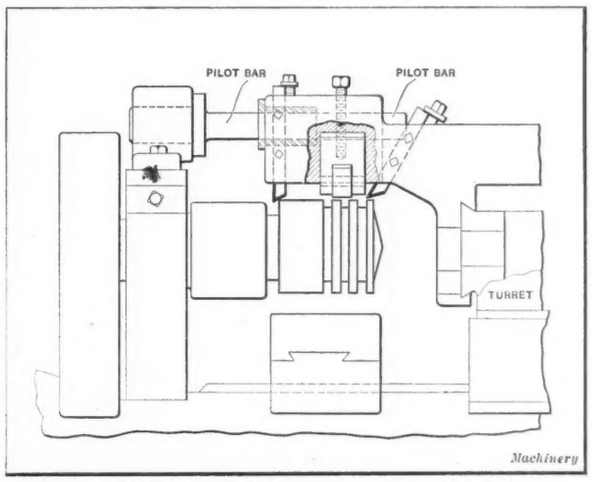

Fig. 5. Pilot held in Headstock Bracket and piloted into Back-rest

Another point which does not make itself quite clear to the writer is the method of using the adjusting tool block (Fig. 8 in Mr. Dowd's article) and why it is necessary to have the thrust of the cut come against the screws instead of placing the block on the opposite side and having the cut come against the solid metal. This would require the pilot to come on the opposite side, to which I can see no objection, as it has been done on the equipments shown in other illustrations. As regards the adjusting features shown in Fig. 8, it appears that when the screws in the slots for adjusting the block *D* are loosened, the screws which hold the blade will also become loose, thereby permitting the blade to fall out, thus losing its value as an adjusting feature in the true sense of the word. Although I have taken the article in question and discussed it at some length, I can offer no apologies, having merely done as a tool designer would do while checking with the intention of bettering the design without going too much into detail. Lack of completeness in the drawings of tool set-ups shown would make this impossible, as where one unit in a tool set-up is shown without regard to the manner in which it matches up with the other tools in the combination, it is impossible to see just how the whole will work together for the best operation.

AUTOMATIC HEAT CONTROL

BY E. P. REICHHELM*

Every practical mechanic realizes the importance of heating steel work so that when quenched it has the exact temperature required for perfect hardening. Excellent work in hardening has been done for centuries, but it depended for quality upon individual skill, trained eyesight and intuition, and even the best hardener could rarely repeat the same results until the pyrometer enabled him to make a record of the exact heat required to harden a given steel properly. Since pyrometers have come into common use, the hardener's principal care has been to maintain the correct furnace temperature by watching his pyrometer and regulating his gas and air valves so as to maintain it. Any experienced hardener will grant that before he used a pyrometer he was unable to judge his heat nearly as correctly, and that a decided advance in the art of hardening was made when the pyrometer replaced eyesight and intuition and enabled him to record his experience in figures instead of relying upon his own judgment.

The next step in securing uniformity and high quality of hardening was to find a means of supplying gas and air to a gas furnace in exact proportion to the required temperature. The automatic heat controller of the American Gas Furnace Co. is such an instrument. In daily use for over three years in shops and laboratories, both here and in Europe, it has demonstrated conclusively that essential differences in temperature affecting the results of heating processes are practically unavoidable unless the furnace is automatically controlled, because even the most skillful and careful operator is unable to check or increase furnace heats promptly enough to avoid variations from the desired temperature, which, no matter how closely his pyrometer is observed, may easily vary from 50 to 100 degrees.

The detrimental effect of such heat variations in hardening are shown in the following microscopic photographs of two fractures of the same file magnified 160 times. This file is one of the highest grade produced in Europe, and Fig. 1 shows the fracture of this file as imported, while Fig. 2 shows a fracture of the same file, a section of which was rehardened, after the exact degree of heat required for this particular steel had been experimentally determined. Fig. 1 therefore shows the result of the best hardening practice in Europe, aided by the pyrometer, while Fig. 2 shows the hardening of

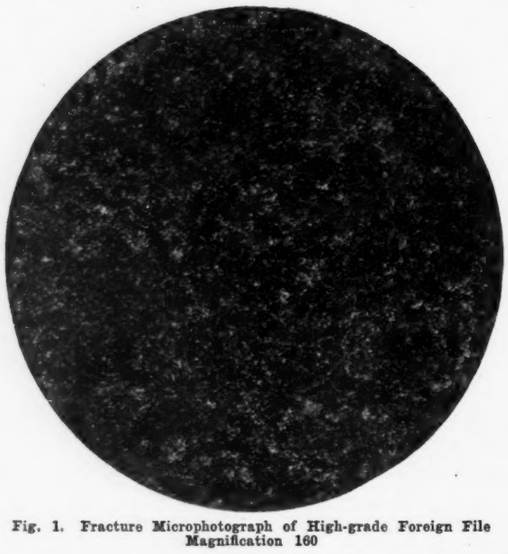

Fig. 1. Fracture Microphotograph of High-grade Foreign File Magnification 160

this identical file by the correct heat automatically maintained. That any number of files, or tools of any kind, can be hardened so as to show uniformly the excellent fracture exhibited in Fig. 2 is due to automatic heat control, as has been demonstrated conclusively in daily practice for over three years.

Both of the photographs of fractures have been pronounced excellent by competent judges, but the decidedly finer grain and more even diffusion of the carbon shown in Fig. 2 produced a difference in the durability of the file teeth of nearly 50 per cent, as compared with the section of the file as originally hardened and shown in Fig. 1.

When the hardener is released from the constant observation of his pyrometer and the frequent handling of the gas and air valves, his whole attention can be given to his product,

Fig. 2. Fracture Microphotograph of Same File Rehardened Magnification 160

and the output of the man and his furnace is greatly increased, to say nothing of the uniformity and superior quality of the work, which makes the installation of the automatic heat controller only a question of how soon it can be made to pay for itself; and this depends entirely upon the amount of hardening to be done. The same instrument can be used for the equally important process of annealing by simply switching it off to an annealing oven.

It might be doubted whether the file from which these fractures are shown was hardened as perfectly as the makers could do it, but there can be no doubt that this file was improved by more correct hardening, and that any number of files made of the same steel can be hardened exactly as shown in the fracture Fig. 2. The result shown is entirely due to the automatic heat controller and deserves the attention of progressive manufacturers, who desire to produce the best possible work, to stimulate the demand for things "made in the U. S. A."

* * *

HANDLING OFFICE VISITORS

The problem of treating factory visitors in a courteous manner is often a difficult one. Good business principles demand that any caller at the office, no matter what his errand, shall be given a courteous hearing, even though brief. One large concern in the machine tool building field has an efficient method of handling callers which is very effective in operation and which saves the valuable time of the management. It fulfills the requirements of courtesy, giving every visitor the opportunity to present his case. The visitor, whether he be book agent or prospective customer, is received courteously, his card taken and he is shown to a seat. The telephone operator announces him to the official whom he desires to see, and he is then invited to step into a well-appointed telephone booth where there is good light, chair, pencil and paper. The person with whom the interview is requested directs the visitor to state his mission over the telephone, and if it is one deserving more personal attention he is invited into the office, but if the preliminary talk indicates that the visitor has nothing of interest, he is told firmly but courteously that such is the case, and the receiver is hung up. There can be no hanging on by the persistent salesman, no idle talk about the weather, the political situation or any of the many time-consuming and irritating matters broached when the visitor is received in the office.

* President and general manager American Gas Furnace Co., 24 John St., New York City.

A SPEED RECORD IN DRILLING

During the recent Foundry & Machine Exhibition in Chicago, the Colburn Machine Tool Co., of Franklin, Pa., had one of its D-4 drill presses in operation. In drilling iron and steel, this machine established records which are of such an exceptional character that a more extended account than that given in the October number will doubtless prove of interest to readers of MACHINERY. The machine was taken from the manufacturer's regular stock and ordinary commercial drills made by three different firms were used. Consequently, these results are nothing which a manufacturer cannot hope to obtain under actual shop conditions. The drill press was driven by a 25 horsepower constant speed motor and the small amount of power consumed, considering the heavy drilling which was done, was quite remarkable. The reason for this low power consumption is in a large measure due to the fact that the machine is provided with ball bearings throughout the driving train, in addition to ball thrust bearings for the drill spindle.

Among the numerous interesting examples of high-speed drilling done on this machine there was one which is believed

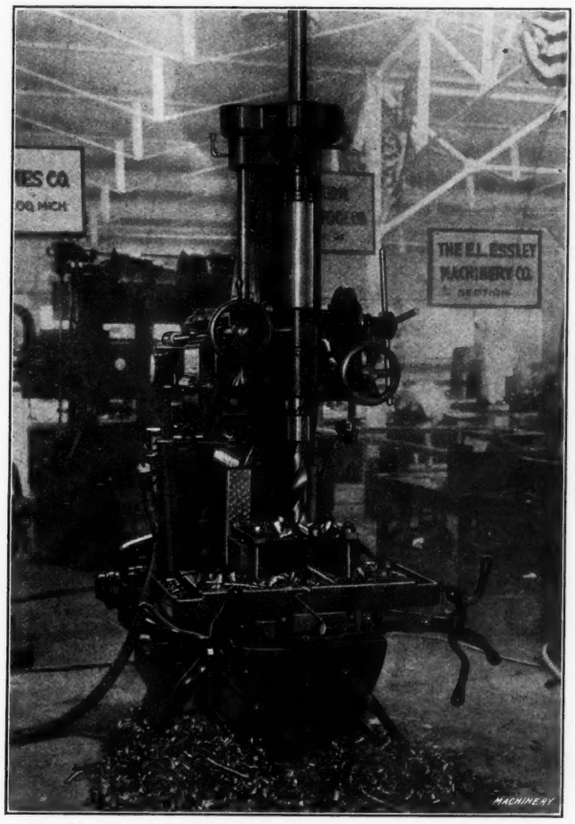

Fig. 1. Colburn D-4 Drilling Machine on which Record was made

to stand as the record for drilling in steel. A 1½ inch twist drill was driven through a piece of 0.35 to 0.40 per cent carbon steel, 4 inches in thickness, at a speed of 343 revolutions per minute and a feed of 0.061 inch per revolution. This means that the drill was advanced at a rate of 20.92 inches per minute. Three holes were drilled at this rate, and after the third hole was finished the drill was still in good condition and could have drilled several more holes at the same rate without the necessity of sharpening. After conducting this exhibition, another make of drill of the same size was put in the machine and two holes were drilled at the same speed and feed. After drilling two holes, this drill was still in fair condition and would easily have drilled another hole under the same conditions without the necessity of sharpening.

Attention is called to the interesting character of the chips made with drills running under these extremely heavy feeds. All the chips shown in Figs. 2 and 3 were made with the same 1½ inch drill, running at the speed and feed referred to in the preceding paragraph, *i.e.*, 343 revolutions per minute

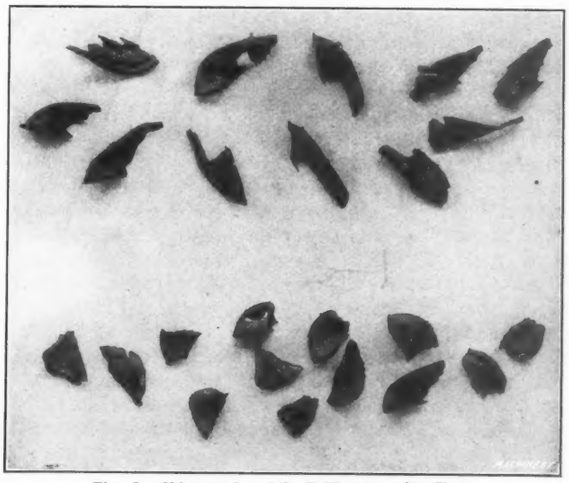

Fig. 2. Chips made while Drill was quite Sharp

and 0.061 inch per revolution. The great difference in the appearance of the chips is due to the relative change in the sharpness of the cutting edges of the drill. The chips shown in the lower part of Fig. 2 were made when the drill was quite sharp, and as the drill became dull the chips assumed the shape of those shown in the upper part of the illustration. Finally, as the cutting edges of the drill became ragged, the chips assumed the grotesque and rather ornamental shapes shown in Fig. 3. It would hardly seem possible that all these chips were made with the same drill working under the same speed and feed, and that the factor entirely responsible for their changed appearance was the degree of sharpness of the cutting edges. Another interesting fact brought out by these chips is that the drill is much more likely to break when it is dull than when kept sharp. This is fairly evident from the fact that the long, irregular chips made when the drill is dull, have a tendency to clog up the hole and wedge the drill, thus causing it to break. On the other hand, the short chips made with the drill when it is sharp clear themselves freely without any disposition to clog.

A further idea of the exceptionally high rate at which the preceding exhibitions were conducted will be gained from the fact that at this rate, 621 pounds of chips would have been made per hour, which is equivalent to over three tons of chips in a ten-hour day. However, as a machine for converting metal into chips, the following record which this machine established in drilling cast iron is even more remarkable. A 3-inch twist drill running at 343 R. P. M. with a feed of 0.061 inch per revolution, was driven through a cast-iron block 4½ inches in thickness twelve times without the necessity of re-grinding. After drilling twelve holes at this rate, the supply of material was exhausted so that the test could not be continued, but the drill was still in good condition, showing no necessity for re-sharpening. The amount of chips made under these conditions seems almost unbelievable, as it would amount to 2310 pounds per hour, or over 11½ tons in a ten-hour day.

Fig. 3. Form assumed by Chips as Drill became Dull

In conducting these exhibitions, none of the drills were broken and this fact naturally leads one to inquire how this was possible under such severe operating conditions. It could only be done on a machine combining great rigidity of construction with an abundance of power. The factor of prime importance in the elimination of broken drills is to have the machine absolutely rigid. If there is any spring between the upper part of the machine and the table, the drill will not start cutting until the pressure is sufficient to overcome this strain, after which the feed is practically constant until the point of the drill breaks through. The resistance to the penetration of the drill is then removed and if there is any spring in the parts, it causes the drill to "hog in." The sudden increase in torsional strain produced in this way frequently causes the drill to break. Another condition that results in broken drills, which is also brought about by the same spring in the parts referred to, is that any movement of the table in relation to the upper part of the machine causes the spindle to be thrown out of alignment, with the result that the drill tends to bend and cramp in the hole. If the hole is deep, this is frequently the cause of breaking the drill, even though its cutting edges are perfectly sharp. It will be evident from Fig. 1 that the construction of the Colburn drill press is exceptionally massive, so that strain is effectually eliminated. The provision of ball bearing journals, helical driving gears on the spindle, and feed gears running in oil, affords the greatest possible smoothness of operation.

* * *

RECENT LEGAL DECISIONS INVOLVING MACHINERY

A careful analysis of recent court decisions has been made, and the result is given herewith for the benefit of the readers of MACHINERY. All necessary references to court records are given in each case.

Sales of Machinery on Open Account

(Federal) Where certain goods were sold by the claimant to the bankrupt on open account, the title vested in the bankrupt at once, and the relation of debtor and creditor created, so that on bankruptcy intervening the seller could not rescind the sale and recover the goods.—*In Re Caldwell Machinery Co. 215 Fed. 428.*

Injury Caused by Salesman in Demonstrating Machine

(Federal) Defendant sold certain paper cutting machines to be erected by it in a printing office in another city, and sent an agent to install the same. Almost as soon as the last machine had been set up the agent started to return, but before his train had left was sent for by the purchaser because plaintiff, who was to operate one of the machines, could not make it work properly. He returned, and the evidence as to what was done was in some conflict, but in explaining the operation of the machine to the foreman, the agent moved the lever, which caused the cutter to fall, and plaintiff's hand was caught and cut off. There was evidence for plaintiff that the machine had not been tested to its capacity, and was not in complete running order; that plaintiff was directed to do certain things, and that the agent himself made further adjustments. Held, that it was not error to submit to the jury the question whether the agent, when he moved the lever, was acting for defendant, and not for the purchaser, and within his authority as defendant's agent. The jury found for plaintiff.—*Seybold Machine Co. v. Feehan. 214 Fed. 915.*

Misstatements in Specifications

(Federal) That the specification makes exaggerated or unwarranted statements as to the capabilities of the invention, even conceding that an infringer can interpose that as a defense, does not render the patent invalid, unless the statements were made fradulently, and the patentee was a party thereto.—*Universal Tobacco Machine Co. v. Borgfeldt S. M. Co. 215 Fed. 715.*

Hoisting Apparatus Held Infringed

(Federal) In a suit charging the infringement of an invention having relation to an improvement in hoisting apparatus which includes a pair of superimposed engines, the defense was made that no infringement existed for the reason that the apparatus in question was a combination of features which had in the past existed in other apparatus. The evidence established the fact that the combination was nothing more than the placing of two engines one on top of the other, each operating independently, and that such engines individually were covered by previous patents. The Court held that to constitute a combination it is essential that there should be some joint operation, performed by the elements producing a result due to their joint and cooperating action, while in an "aggregation" there is a mere adding together of separate contributions, each operating independently of the others. The apparatus in question must be considered to be an "aggregation" rather than a combination, simply for the reason that the engines contained in it operate separately and independently to each other. The plaintiff's engine must be held infringed by defendant's hoisting apparatus. Decree for plaintiff.—*Mead Morrison Mfg. Co. v. Exeter Machine Works. 215 Fed. 731.*

Indivisible Contract of Sale

(Ohio) A written contract for the sale of several articles of machinery for a sum in gross is indivisible except by subsequent agreement of the parties, and the seller cannot recover the contract price or any part thereof unless he substantially performs, or tenders performance of, all the terms of the contract on his part to be performed.

Where a contract for the sale of machinery specifically provides for the manner and method of delivery, the seller has no right or authority to impose other or further conditions precedent to delivery than those named in the contract.—*Petersburg Fire Brick & Tile Co. v. American Clay Machinery Co. 106 N. E. 33.*

May Enjoin Infringement

(New York) A manufacturer who produces a machine of recognized excellence in the market, and stamps the same with his trade name or mark, acquires a property right in it which the law will protect from infringement.—*Payn's Sons Co. v. Payette. 149 N. Y. S. 184.*

Belt Shifters must be Provided

(Kansas) The State Factory Act of Kansas (Gen. Stat. 1909, sec. 4679) provides that belt shifters shall be provided in all manufacturing establishments in which machinery is used and that machines shall be operated with loose pulleys when practicable. In construing this act the Kansas courts have held that the law must be strictly complied with, and substitutes, no matter how safe and convenient, will not be considered a compliance with the law.—*Rank v. Kansas City Packing Box Co. 142 Pac. 942.*

Subject of Protection

(Federal) To entitle a complainant manufacturer to protection against the use of its unpatented machines and methods by others, it must appear that they are in fact secret, and it is not entitled to an injunction to restrain the use of machines copied from its own by another manufacturer, which obtained its information respecting the same from former employes of complainant, who were not informed and had no knowledge that the same were secret.—*Hamilton Mfg. Co. v. Tubbs Mfg. Co. 216 Fed. 401.*

Duty of Foreman Having Charge of Machinery

(Federal) A foreman, having charge of and controlling workmen, is presumed to observe the presence or absence of proper safety appliances and to know the danger of working at rapidly revolving machinery without such appliances, and it is his duty to warn those working under his direction and control of dangers not obvious to them.—*Russell v. Champion Fiber Co. 214 Fed. 963.*

Implied Warranty in Sale of Machinery

(Kentucky) Where plaintiff purchased a certain piece of machinery, and it proved inadequate, plaintiff's retention of the machine for about sixty days during which time he thoroughly tried it, and it was repaired and adjusted by experts from the seller, was not such a delay as to preclude him from rescinding the contract of purchase. Where a seller contracts to supply a piece of machinery to be applied to a particular purpose, and the buyer necessarily trusts to his skill or judgment, there is an implied warranty that the machine will reasonably perform the duty for which it is to be applied.—*International Harvester Co. v. Bean. 169 S. W. 549.*

OPERATION OF GRINDING WHEELS IN MACHINE GRINDING*†

APPLICATION OF MATHEMATICAL ANALYSIS TO THE PROBLEMS OF WHEEL AND WORK SPEEDS IN GRINDING

LONG experience in the use of grinding wheels has established facts regarding the action of such wheels when used on modern grinding machines. These facts, however, have been stated only as empirical rules. Such rules are easily forgotten or confused by operators because they are not related in any obvious way to any known principles by which results may be predicted. For example, what is the effect upon a wheel of increasing the speed of work, or of increasing the diameter of the work, or of diminishing the diameter of the wheel? The following analysis of the action of the grinding wheel when operating upon cylindrical or plane surface work, reveals a principle which leads at once to the answers to questions like those in the preceding sentence. In all cases the term "speed," whether referring to work or to wheel, means peripheral speed.

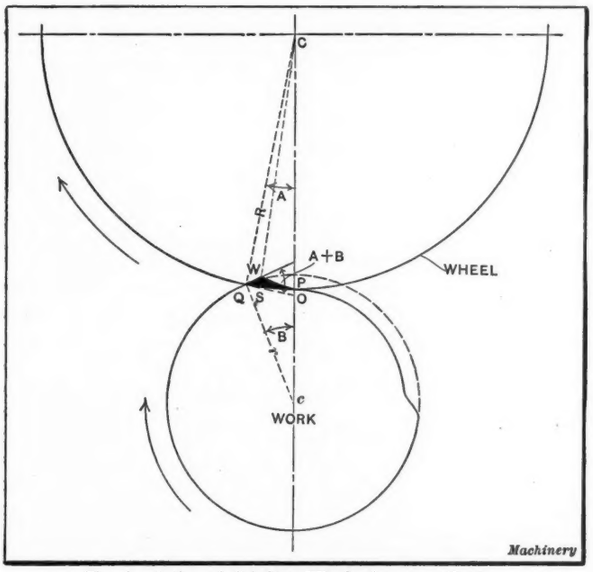

Fig. 1. Action of Grinding Wheel when operating on Cylindrical Work

In Fig. 1 let

C = the center of the wheel;
c = the center of the work;
OP = the radial depth of cut;
OQ = the arc of contact of wheel and work.

Each of these dimensions is much exaggerated in the figure, the real dimensions in actual work being exceedingly small. The arrows indicate the direction of motion of wheel and work, respectively. Assume for a moment that there is but one abrasive grain or cutting point in the surface of the wheel, and that this one grain is at O. On account of the revolution of the wheel, the point O will move to Q in a certain time, but on account of the revolution of the work, the point Q on the work will move toward P, to the point W. As the speed of the work is usually very much less than the speed of the wheel, this distance QW will be much less than OQ. The cutting point will remove from the work a chip represented by OQW. From the outline or shape of the chip it appears at once that when the cutting point begins to act at O, its depth of cut is nothing, but that the depth of cut of the grain increases gradually to its maximum WS. As the abrasive grain in a grinding wheel is set or fixed in the bond of the wheel, it is clear that the deeper the grain cuts into the work, the more the bond will be disturbed, or worn away. The distance WS will be called the maximum grain depth of cut, or, for brevity, the grain depth of cut. Of course, there are actually a number of cutting particles between O and Q, but each acts in the same manner as the single grain we have considered. The grain depth of cut of each particle, however, will be the distance WS divided by the number of cutting grains or particles in action at once, or the number between O and Q. When a grinding wheel is working properly, we may consider the abrasive grain in the wheel as cutting small chips from the work, and the surface of the work as cutting or wearing away the bond of the wheel. Now, it is quite evident that the greater the grain depth of cut, the more effective will be the action of the work upon the bond of the wheel. So long as the bond is being worn away just as fast as the abrasive grains of the wheel are being worn down, the wheel will continue to work well. If the bond is cut away too rapidly, the wheel will appear too soft, and will wear away too rapidly. If the cutting grains wear down faster than the bond is cut or worn away, the face of the wheel will become glossy, and the wheel will not cut freely. These considerations lead directly to the conclusion that the action of a given wheel on a given kind of work is almost entirely dependent upon the grain depth of cut. If the grain depth is too great, the wheel wears away too rapidly. If the grain depth is too small, the wheel may glaze. It is therefore important to know how the grain depth of cut may be regulated.

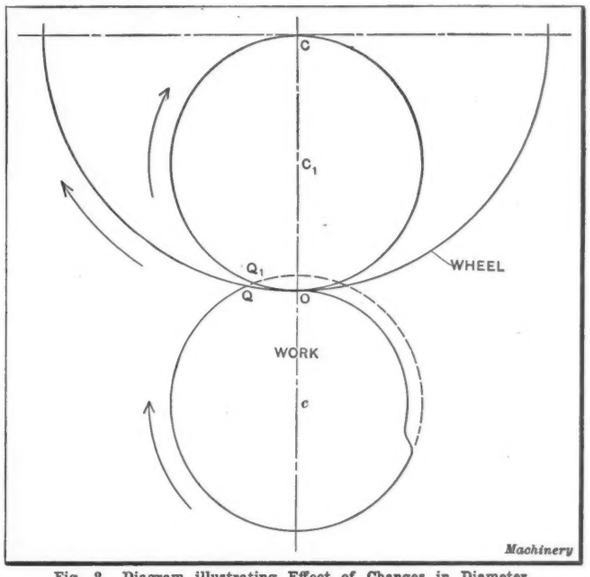

Fig. 2. Diagram illustrating Effect of Changes in Diameter of Wheel or Work

Referring again to Fig. 1, it appears that WS will increase if QW increases and *vice versa;* but QW depends upon the speed of the work. Therefore if the speed of the wheel remains constant, and the speed of the work increases, WS will increase. The correct working of the wheel therefore depends upon the relation of QW to OQ, or upon the relation of work speed to wheel speed. If the wheel speed and all other conditions except work speed remain constant, the grain depth will increase as the work speed increases, and diminish as the work speed diminishes. Also the work speed and all other conditions except wheel speed remaining constant, the grain depth of cut will increase as the wheel speed diminishes and *vice versa.*

Effect of Changes in Diameter of Wheel or Work

In Fig. 2, let

C = the center of a grinding wheel;
C_1 = center of a smaller grinding wheel;
c = the center of work.

Suppose the wheel the center of which is at C, to have worn down until its center is at C_1, the work diameter remaining the same. Let the radial depth and work speed also remain

* Paper to be read by George I. Alden before the American Society of Mechanical Engineers, New York City, December, 1-4, 1914.
† For additional information on grinding see "Selection of Wheels for Cylindrical Grinding," October, 1914; "Efficient Production of Cylindrical Work," December, 1912, and other articles there referred to.

constant. This insures the same rate of production in each case. Let the wheel speed also be the same in each case. It will be seen from Fig. 2 that the smaller wheel will have a shorter arc of contact with the work than has the larger wheel, or that OQ_1 is less than OQ. Since the wheel speed in both cases is assumed to be the same, the number of chips cut from the work each minute will be the same; but as the chips cut by the smaller wheel are shorter, and as the volume of all the chips cut each minute is the same, it follows that the thickness of the chips cut by the smaller wheel is greater than the thickness of the chips cut by the larger wheel. In other words, the grain depth of cut increases as the wheel diameter diminishes. Therefore the bond should wear away faster as the wheel gets smaller, and the smaller wheel should appear softer.

In many cases as the wheel wears down, the speed of the wheel is allowed to diminish, and when this is the case the grain depth of cut will be increased on account of the diminished wheel speed, as well as because of the smaller wheel. Following the same line of reasoning, it is easily shown that if the work diameter is increased (all other factors remaining the same) a longer chip will be cut from the work, and as the number and volume of chips remain constant for each unit of time, the thickness of the chips must diminish, or the grain depth must be less. Therefore a wheel, other conditions being the same, should appear harder as the diameter of the work increases. A proper increase of work speed on the larger work will bring up the grain depth of cut to what it was on the smaller work.

Summarizing these conclusions, to which we are led by purely theoretical considerations, we can say:

1. Other factors remaining constant, increase of work speed increases grain depth of cut, and makes a wheel appear softer.
2. Similarly, a decrease of wheel speed increases grain depth of cut.
3. Similarly, diminishing the diameter of the grinding wheel increases grain depth of cut, and increasing the diameter of the wheel decreases grain depth of cut.
4. Similarly, making the diameter of work smaller increases grain depth of cut. Conversely, making the diameter of work larger makes grain depth of cut smaller.

In the above analysis no account has been taken of certain factors that no doubt modify, to a degree, the results arrived at. For example, chips cut from the work by the abrasive particles of the grinding wheel are not entirely free to escape. Referring to Fig. 1, the arc OQ will, in practice, contain several cutting points, so that several chips are in the process of being cut off at once. Before these chips all escape, some of them may be forced into spaces between the cutting particles in the face of the wheel, causing the wheel to "load." This loading may at times be such as greatly to reduce or even practically to destroy the cutting quality of the wheel. Even though the wheel does not "load," the presence of loose chips of metal between the wheel and the work may impair the cutting action of the wheel or the quality of the ground surface produced; but the four conclusions given in the preceding paragraph are recommended as giving correct relative results.

In applying the principle that grain depth of cut is the main factor in all the phenomena of a good grinding wheel, it must be remembered that the correct relative speeds of work and of wheel must be found by trial for each wheel and each kind of work. When this has been done, the principle of grain depth of cut will enable one to know the direction in which to make the changes of work speed or wheel speed, to adapt the wheel to changes in its own diameter, or to other sizes of the same kind of work.

Finishing

Thus far it has been assumed that the object of grinding is to remove stock rapidly or, in other words, to get a high rate of production. Often, however, the character or finish of a ground surface is of primary importance. From the point of view of grain depth of cut, we should reason that to get a very smooth surface by grinding, the grain depth of cut should be very small, and, therefore, that the work speed should be relatively slower for finishing than for roughing. That the bond may be worn away by a very small grain depth of cut, we should expect that generally a softer wheel would be used for fine finishing than for roughing. A very hard glazed wheel may sometimes produce a mirror-like surface on the work, the action in this case being a sort of burnishing process.

Mathematical Analysis

A general equation for grain depth of cut may be obtained as follows: Referring again to Fig. 1, let

$OQ = l$ = arc of contact of wheel and work;
n = number of cutting particles per unit length of circumference of wheel;
V = surface velocity of the wheel;
v = surface velocity of the work;
T = time it takes point on *wheel* to go from O to Q and also time it takes point on *work* to go from Q to W;
d = grain depth of cut.

Then

$$l = VT \text{ or } T = \frac{l}{V} \tag{1}$$

$$QW = vT \tag{2}$$

and

$$WS = vT \sin (A + B) \tag{3}$$

$$d = \frac{WS}{nl} = \frac{vT}{nl} \sin (A + B) \tag{4}$$

Substituting T from (1)

$$d = \frac{v}{Vn} \sin (A + B) \tag{5}$$

Equation (5) shows that the radial depth of cut varies directly as work speed; inversely as wheel speed; and directly as sin $(A + B)$. To give the reader an idea of the dimensions of some of the quantities entering into Equation (5) and also a means of determining from (5) the change in grain depth of cut due to changes in radial depth, Table I giving lengths of arcs of contact of wheel and work for three different diameters of wheels, and Table II giving the values of sin $(A + B)$ for the dimensions of wheel and arcs of contact given in Table I, are appended.

TABLE I. ARCS OF CONTACT

	Rad. Depth of Cut, Inches	0.0005	0.001	0.0015	0.002	0.0025	0.003
	Work Diam., Inches	Arcs of Contact					
12-inch Wheel	½	0.0158	0.0210	0.0270	0.0307	0.0346	0.0378
	1	0.0212	0 0318	0 0373	0.0429	0.0482	0.0526
	2	0.0291	0.0413	0.0507	0.0584	0.0654	0.0711
	3	0.0346	0.0490	0.0600	0.0692	0.0775	0.0848
	4	0.0386	0.0547	0.0689	0.0775	0.0866	0.0949
	6	0.0448	0.0634	0.0774	0.0894	0.1001	0.1095
	8						
	12						
	24						
	∞	0.0775	0.1095	0.1342	0.1549	0.1732	0.1898
18-inch Wheel	½						
	1	0.0220	0.0311	0.0377	0.0436	0.0485	0.0533
	2	0.0299	0.0428	0.0521	0.0598	0.0669	0.0735
	3	0.0362	0.0504	0.0620	0.0717	0.0801	0.0878
	4	0.0401	0.0574	0.0699	0.0810	0.0900	0.0990
	6	0.0477	0.0672	0.0824	0.0950	0.1061	0.1162
	8						
	12						
	24						
	∞	0.0948	0.1341	0.1638	0.1897	0.2121	0.2324
24-inch Wheel	½						
	1						
	2	0.0294	0.0423	0.0521	0.0604	0.0676	0.0742
	3	0.0364	0.0515	0.0631	0.0728	0.0814	0.0892
	4	0.0407	0.0582	0.0714	0.0827	0.0925	0.1013
	6	0.0489	0.0691	0.0846	0.0977	0.1095	0.1189
	8	0.0546	0.0773	0.0947	0.1095	0.1224	0.1340
	12	0.0631	0.0895	0.1093	0.1264	0.1413	0.1549
	24	0.0777	0.1095	0.1342	0.1549	0.1731	0.1896
	∞	0.1097	0.1548	0.1896	0.2189	0.2448	0.2682

Machinery

Values of sin $(A + B)$. To show how grain depth varies by the changes of radial depth in special cases, three examples are computed with the following results.

Example 1. $R = 9$ inches; $r = 4$ inches.

Radial depth 0.0015; sin $(A + B) = 0.03285$.

Radial depth 0.003; sin $(A + B) = 0.04650$.

In this case double radial depth gives an increase of only about 40 per cent in grain depth.

Example 2. $R = 9$ inches; $r = 2$ inches.

Radial depth 0.0015; sin $(A + B) = 0.04271$.

Radial depth 0.003; sin $(A + B) = 0.06051$.

Increase of about 40 per cent.

Example 3. $R = 9$ inches; $r = 1$ inch.

Radial depth 0.0015; sin $(A + B) = 0.05793$.

Radial depth 0.003; sin $(A + B) = 0.08167$.

Increase of about 41 per cent.

Examples might be multiplied, but those cited are sufficient to show that increase of radial depth does not increase grain depth in the same proportion as the radial depth increases. In the first example, doubling the radial depth gives only about 40 per cent increase in grain depth. Resuming the equation $d = \frac{v}{Vn} \sin (A + B)$ which is Equation (5), we see that if sin $(A + B)$ is increased say 40 per cent by doubling the rádial depth, we might diminish $\frac{v}{V}$ by about 30 per cent without changing the grain depth; but these changes, which have not varied the theoretical value of grain depth d have increased the rate of production 40 per cent. This indicates that production may be increased without increasing grain depth of cut, by increasing the radial depth of cut, and at the same time diminishing the work speed a less per cent than the radial depth is increased. In practicing this method of increasing production it is assumed that the work and the machine are reasonably rigid.

Summary

All the above results, which have been obtained from purely theoretical considerations, are based on the principle that the successful working of a grinding wheel depends upon securing in its operation the correct grain depth of cut for that particular wheel on a specified kind of work. It remains for expert users of wheels to decide from practice the correctness of these theoretical results. While the matter of clearance and of the unequal diameters and irregular arrangement of the abrasive grains may modify to some degree the theoretical results, it is confidently believed that the theory based on the idea of grain depth of cut will always lead in the right direction, and that it gives to empirical rules for changes of work and wheel speeds, a rational basis, and affords the operator an opportunity to do by thought and reason what heretofore he has done by memory alone.

This brief paper may suggest a line of investigation which, with the aid of sufficient data from practical experience, will lead to some definite directions for the use of standard grinding wheels on cylindrical and plane surface work.

TABLE II. SIN $(A + B)$

Rad. Depth of Cut, Inches		0.0005	0.001	0.0015	0.002	0.0025	0.003
	Work Diam., Inches	Sin $(A + B)$					
12-inch Wheel	½	0.06581	0.09678	0.10999	0.12807	0.14379	0.15724
	1	0.04686	0.06888	0.08084	0.09287	0.10439	0.11396
	2	0.03394	0.04822	0.05914	0.06816	0.07626	0.08294
	3	0.02879	0.04075	0.04997	0.05768	0.06453	0.07066
	4	0.02573	0.03649	0.04589	0.05163	0.05769	0.06323
	6	0.02238	0.03167	0.03868	0.04469	0.05002	0.05475
	8						
	12						
	24						
	∞	0.01291	0.01826	0.02236	0.02582	0.02886	0.03162
18-inch Wheel	½						
	1	0.06394	0.06596	0.07948	0.09210	0.10231	0.11224
	2	0.03321	0.04751	0.05793	0.06645	0.07430	0.08167
	3	0.02813	0.03916	0.04842	0.05578	0.06229	0.06830
	4	0.02448	0.03501	0.04271	0.04951	0.05497	0.06051
	6	0.02119	0.02981	0.03661	0.04221	0.04715	0.05163
	8						
	12						
	24						
	∞	0.01053	0.01490	0.01826	0.02108	0.02356	0.02582
24-inch Wheel	½						
	1						
	2	0.03246	0.04582	0.05647	0.06541	0.07322	0.08903
	3	0.02731	0.03861	0.04730	0.05462	0.05817	0.06687
	4	0.02375	0.03394	0.04167	0.04822	0.05395	0.05910
	6	0.02036	0.02877	0.03535	0.04069	0.04564	0.04997
	8	0.01821	0.02575	0.03155	0.03651	0.04080	0.04467
	12	0.01576	0.02238	0.02731	0.03160	0.03531	0.03872
	24	0.01294	0.01826	0.02238	0.02582	0.02885	0.03160
	∞	0.00914	0.01290	0.01580	0.01824	0.02045	0.02235

Machinery

* * *

THE MICROMETER CALIPER AS A MACHINE SHOP GAGE

SOME REMINISCENCES AND IDEAS OF A WELL-KNOWN MANUFACTURER OF MEASURING TOOLS

BY J. T. SLOCOMB*†

J. T. Slocomb

My first experience in a machine shop was in 1881 at Bangor, Maine. It was in a shop devoted to general saw mill work and to all sorts of jobbing. We had a great variety of fits to make, often having to bore a hub for a driving fit on a shaft that was miles away from the shop. We were not provided with hydraulic presses, screw presses or much of anything else in the line of convenience. The only way of forcing fits was with sledge hammer, driving on a wooden block. If a hub was forced part way on and stopped, it was likely to make a lot of trouble. These things led me to a strong belief that something better than the calipers we were using would be a godsend to shops of our kind. In 1885 I went to work for the Brainard Milling Machine Co. in Hyde Park, Mass., and it was there I saw the first micrometer caliper. In a conversation one day with Mr. M—— he asked if I had ever seen a micrometer, and then produced one from his kit where he had it carefully nested in some clean cotton waste. He told me it was a good tool to find odd sizes of wire with. This started me to thinking and, as my experience had not included wire work, I naturally began to associate this new magnifying gage with general machine shop work.

About a year later, I went to work for the Brown & Sharpe Mfg. Co. at Providence, R. I. Although the B. & S. Co. had been making these calipers in small sizes for fifteen years or more, it seemed that for general machine work they had not fully appreciated their value. One of the foremen had a two-inch micrometer that he had made himself, and said he graduated it with a monkey wrench. This caliper was the most borrowed tool I ever saw, which, of course, went to show the demand for such a tool in that shop. Several years later through one of the queer turns of fate, I found myself associated with a small manufacturing business. In the summer of 1892 or 1893 we were struggling along under a panicky business condition, a time which will be remembered by a great many. The lack of regular work at that time gave me plenty of opportunity to make plans, and then the old idea of an improved machine shop gage began to take form which resulted in the Slocomb micrometer. It seemed that there was a field for these instruments in the larger

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† J. T. Slocomb was born at Four Falls, New Brunswick, Canada, in 1864. His parents moved to Maine when he was an infant and he lived in Fort Fairfield, Maine, until he was sixteen years old, when he went to Bangor and entered the employ of the Bangor Foundry & Machine Co. as a machinists' apprentice. He worked there four years and then went to the Brainard Milling Machine Co. at Hyde Park, Mass., afterward working for short periods for H. B. Smith Machine Co., Smithville, N. J., Holyoke Machine Co., Holyoke, Mass., Brown & Sharpe Mfg. Co., Providence, R. I., and the Rhode Island Locomotive Works, Providence, R. I. He began the manufacture of the Slocomb micrometer in 1893.

sizes. The first micrometers undertaken were the sizes between 3 inches and 8 inches. We found, however, that the market was not ready for large sizes and for this reason were forced to make the smaller ones as well.

One of our first orders came from a Cleveland dealer for four of the 1-inch size. These tools were returned about as promptly as the mail could bring them, with a long friendly letter of advice. The advice was for us to quit the manufacture of such an instrument of precision with the "horseshoe" part finished in black enamel "where it was necessary to be nicely polished." This advice was mainly valuable in showing how micrometers were regarded and what we had to contend with. First came the fellow who stated that the micrometer was too expensive, then the other fellow who stated that it led to mistakes and was not to be trusted, and lastly the party who thought it was jewelry. In designing a micrometer especially for the machine shop, the matter of durability as well as accuracy came in for a large share of attention. Then again, as these tools were intended for everyday service, a matter of finish that was not essential and added to the cost was omitted. These experiences were all gained over twenty years ago, and I view with considerable satisfaction the developments in this time. I have a whole lot of faith in a thing that is *right* winning out if it is persisted in. The importance of making work to interchangeable sizes and the wonderful growth of automobile manufacture has been responsible in a large way for the extended use of micrometers.

There was an idea common twenty years ago that if a lot of snap gages running by even sixteenths of an inch were provided, in some mysterious way all of the variations would adjust themselves naturally. What really happened was that the variations, which were the rule, were taken care of by the fit-together method, and the resulting work was not interchangeable. Looking at this subject squarely, there are a great variety of fits required, calling for a great many measurements. A running fit in a long bearing or hub usually has to have more allowances than where the bearing or hub is short, and the same applies to tight or force fits. Soft or hard materials, thick or thin walls of hubs, rough or smooth surfaces (whether ground or lapped or rough-turned) and the general grade of work all have a bearing on the measurements. In my opinion to meet all of these conditions, the micrometer is the most satisfactory tool known when it is used as it should be. Where approximate measurements are necessary we use a steel scale and read it directly off the work. This not only shows that the work is the desired size, but it shows *how much* larger or smaller it is, which is useful information. In making a nice fit, the micrometer will do the same thing as the steel scale but with the necessary refinement. Do not lock the micrometer to some size and then use it like a snap gage. If you do, you lose three-quarters of its value.

I have not furnished a locking device for the reason that I believe it detrimental to the best use of the micrometer and that it would tend to hinder the general adoption of micrometers in the machine shop. I make a distinction between gaging and measuring. If you are inspecting—only finding out if some size is or is not correct—this gaging might answer, but in the making, where if a size is not correct (which is likely) you want to know how much stock remains, then you want to measure and not gage.

A single micrometer with one inch range will cover the range of about four thousand snap gages besides being valuable in many other ways. Some practice with micrometers is, of course, needed to get the best results, but this is easily attained, and when attained there is no more liability of making mistakes in the reading than there is in the use of the ordinary steel scale. A great help to the use of micrometer calipers is to have graduated dials on all machine adjusting screws for lathes, planers, milling machines, grinders and where fine adjustments are made. These dials should be graduated to read in thousandths inch so that cuts can be adjusted to conform with measurements as found by the micrometer. To be sure, all of these screws are not accurate to pitch, but for the small adjustments necessary the error is not enough to be troublesome. Milling machines and grinding machines have been provided with such dials almost from the first, but they are just as necessary on lathes and planers.

In making interchangeable work, one way that has been in favor for a good many years is to make a sample or model machine, then disassemble the parts and use these as models for duplicating parts. This was the only reasonable way until the advent of micrometer calipers. Today it is perfectly feasible to put all necessary dimensions on a set of drawings so that a machine can be duplicated at any time and make good fits. Besides, this plan will produce better results, because measurements are stated on the drawings, but in the case of the model, measurements of the model have to be made repeatedly with the consequent chances for making errors.

As I stated before, it was difficult to sell micrometers above the two-inch size, but now there is a demand for the large sizes running as high as 36 inches, and even larger. One reason for the demand for these large calipers is that a large shaft costs a good deal of money, and it is important that the greatest care be taken in making the fits, as it costs a great deal more to spoil a large piece than a small one. In the handling of these large micrometers, it has been found a help to use a pulley, cord and weight over the machine to act as a counterweight. This arrangement effects a convenience in having the micrometer always at hand, for the weight can be adjusted slightly in excess so that the caliper stays suspended over the machine but within reach.

On first thought it might appear that micrometers should be made with more than one-inch range each. There are several objections to this plan and there is not much in favor of it. As micrometers are usually made, the spindle or screw when way down overhangs about 1 1/16 inch. A greater overhang than this causes some spring when "feeling" the caliper over the work. This, of course, could be provided for by making the parts larger, but this would necessitate making them heavier which would be an objection. The shorter screw is more easily made accurate and the accuracy is more easily maintained than in a long one. In shops where a good many men are employed, a large number of calipers must be furnished, and they may as well be of different sizes. Some of the devices I have seen for making a micrometer with a two-inch range cost as much to make as two separate micrometers. Sliding anvils and attachments are a source of inaccuracy through maladjustments. In a place where extreme reliability is desired, as in micrometer calipers, it is best to have them simple without attachments and with the least possible chance for mistakes.

* * *

STEEL PUNCHINGS FOR BALL BURNISHING

A use for small, round punchings that are ordinarily a scrap by-product when holes have been punched in machine steel has been found by a concern that does a great deal of ball burnishing on its goods. The punchings are used in the tumbling barrels instead of steel balls. They are first tumbled with no work in place and then, after the corners have been well rounded, the work is put in with the soap-suds solution. The claim is made that the burnishing effect is nearly as good as that obtained when using hardened steel balls, which cost a hundred times as much. Aside from the preliminary tumbling, no preparation of the scrap punchings is required and it is only necessary to replace them as they wear away. The metal dust is carried away with the soap-suds solution in which the work is tumbled. C. L. L.

* * *

RELATION BETWEEN WAGES, LABOR SUPPLY AND LAND

In a recent *Consular and Trade Report*, we find the following statement relating to the conditions in the Marquesas Islands: "The average wage now prevailing in the Marquesas is about 77 cents a day, but in times of competition for a limited supply, as when several vessels happen to be in port at the same time, it often goes as high as $4. The labor problem here, as in Tahiti, is a serious one. Almost all Marquesans own land; there are no poor, as food is obtained with little effort."

THE TOLFORD BALL GRINDING MACHINE*

A MACHINE FOR GRINDING STEEL BALLS WORKING ON A DIFFERENT PRINCIPLE FROM THOSE NOW IN USE

BY CHESTER L. LUCAS†

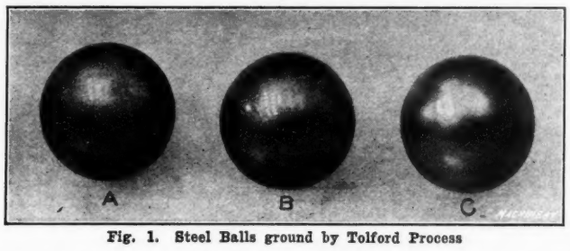


Fig. 1. Steel Balls ground by Tolford Process

THE blanks for steel balls are formed into an approximately spherical shape from steel wire or rods, by dies in either a forging hammer or heading machine. The steel is worked hot or cold, depending upon its composition, the size of the balls, and the practice in the particular shop where the balls are being made. After forming, they are hardened and sent to the rough-grinding machines. These form them very nearly spherical in shape; then they go through a finish-grinding operation that completes them.

The grinding of steel balls is an operation to which much attention has been paid. At present, balls for bearings are ground by rotating them between two disks, one of which is usually of cast iron, having concentric rings or grooves cut for seating the balls, and the other a cup-shaped emery wheel. The spindles of the emery wheel and the cast-iron disk are not in line; hence the paths traveled by the disks are eccentric to each other, giving the balls a radial as well as a curvilinear motion. Fig. 2 illustrates this general principle. The ball is ground to shape and size by removing the metal by a series of flat abrasions, and the rate of grinding, which is governed by the relative velocity between the balls and the disks, is comparatively low. The resulting surface is composed of a succession of minute flat faces, but these are so very small that the ball is acceptable as to shape and size.

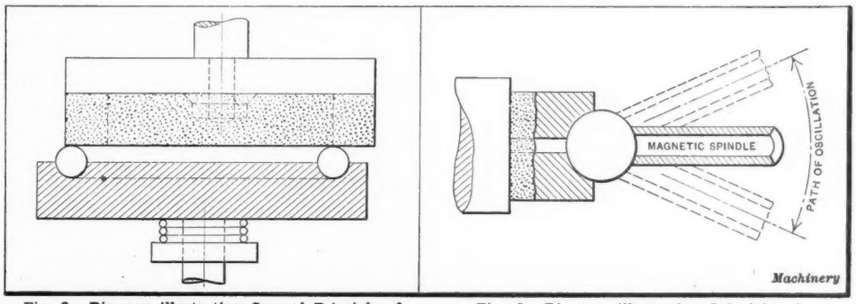


Fig. 2. Diagram illustrating General Principle of Present-day Ball Grinding Operations

Fig. 3. Diagram illustrating Principle of Tolford Ball Grinding Machine

The Tolford Ball Grinding Machine

The Tolford Co. of Hartford, Conn., recently designed and built a ball grinding machine that operates on an entirely different principle. The balls are held individually on spindles and rotated in contact with a grinding wheel that rotates in the opposite direction and at a much higher rate of speed. The grinding surface of the wheel is concaved to fit the size ball being ground. In addition to being rotated, the ball is oscillated on its axis while turning. The three movements of the wheel and ball are illustrated by the diagram Fig. 3 which shows the grinding wheel that revolves in one direction, and the ball spindle that oscillates and revolves in the opposite direction. One of the advantages claimed for the machine is that the balls and grinding wheels have a high relative velocity and consequently the grinding operations are much more quickly performed.

Fig. 1 shows at *A* a ball ground by the Tolford process; at *B* a partly ground ball to illustrate the grinding principle, and at *C* a finished polished ball. The Tolford ball grinding machine is illustrated from the front in Fig. 4 and from the rear in Fig. 5; a view of the driving mechanism for revolving and indexing is shown in Fig. 6; a close view of the oscillating chuck is shown in Fig. 7; a diagram to illustrate the chuck and spindle mechanism is shown in Fig. 8; and in Fig. 9 is a diagram to illustrate the method by which the positions of the balls in the chucks are changed. In general, the machine somewhat resembles a multiple-spindle automatic screw machine in that it has four work-holding spindles that automatically turn and index. In accordance with the description of the principle illustrated in Fig. 3, its functions are to provide for the carrying and rotating of the grinding wheels, the magnetic holding of the balls in oscillating, the rotating of the chucks and the oscillating of each chuck through a path of sixty degrees. In addition, the indexing of the ball-holding spindles must be provided for and the changing of the poles of the grinding operations must be accomplished.

Arrangement of Ball Carrying and Grinding Spindles

Referring now to Figs. 4 and 5 which show the machine from front and rear respectively, it will be seen that there are four spindles for holding the balls during the grinding. These spindles may best be traced from their rear ends,

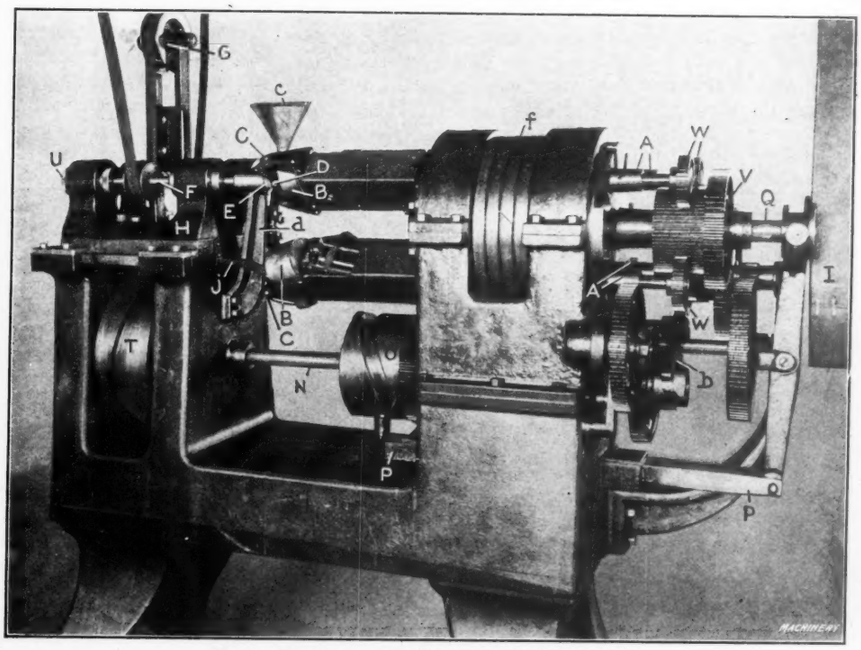


Fig. 4. Front View of Tolford Ball Grinding Machine

* For information relating to the manufacture of steel balls, refer to the following articles previously published in MACHINERY: "The Manufacture of Steel Balls," February, March and April, 1912; "Some Tools Used in the Manufacture of Small Steel Balls," August, 1912.

† Associate Editor of MACHINERY.

which are indicated at *A*. At the forward end of the machine on each of these spindles are the oscillating chucks *B*. The spindles rotate at the same time that the oscillating chucks are swinging about fulcrums *C*, and the balls which are held in the magnetic chucks on the ends of the spindles are rotated as well as oscillated, and a part of the surface of the ball practically equal to a hemisphere is worked upon by the grinding wheel. By looking carefully at Figs. 4 and 5, some of the balls may be seen at *D*. Although there are four work-holding spindles carrying balls, grinding is only performed on the two upper spindles. The third spindle location is used for loading and the fourth spindle is in the ejecting position. One of the two grinding wheels is illustrated at *E*, and in shape it resembles a hollow hemisphere, as can be seen in Fig. 3. These are carried by the two upper spindles *F*. In both Figs. 4 and 5 one of the spindles partly hides the other. By means of an overhead driving belt that passes around the two grinding wheel spindles and an intermediate idler *G*, whose position may be relatively adjusted by a sliding standard on which it is mounted, the spindles are revolved. These two driving spindles *F* are mounted upon a carriage *H*, and this carriage advances and recedes at proper intervals to provide a clear path for the work spindles while indexing. The method of reciprocating the carriage will be touched upon later.

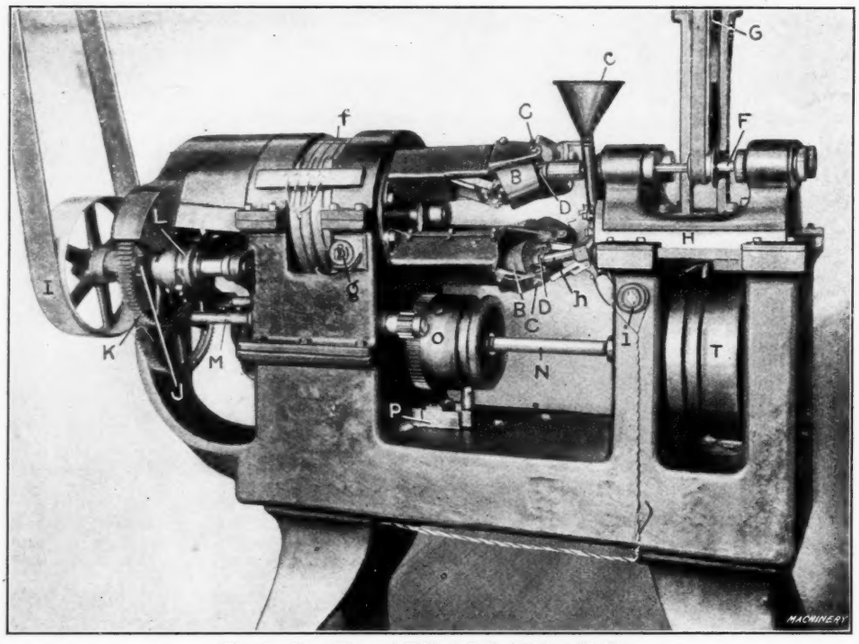


Fig. 5. Rear View of Tolford Ball Grinding Machine

How the Various Movements are Secured

Turning now to the driving end of the machine, best illustrated by Fig. 6, in which the gear guards are shown removed, it will be seen that the main drive is received from the single pulley *I*. From this one drive, by means of the mechanism about to be described, all of the rotating, reciprocating, indexing and oscillating movements are secured except for the rotating of the grinding wheel spindles. Referring back to Fig. 5, it will be seen that the shaft upon which driving pulley *I* is mounted carries the small pinion *J*, the large driving gear *K* and the Carlyle-Johnson friction clutch *L*. Gear *K*, which can be best seen in Fig. 5, meshes with gear *V* which is at the center of the four rotating spindles, Fig. 4. Through a wide gear on the shaft by which gear *V* does the driving, rotation is carried to the four spindles by means of the four smaller gears *W*.

The Chuck Oscillating Mechanism

The function of pinion *J* is to rotate the auxiliary shaft *M* through connection with the gear at its left-hand end as viewed in Fig. 5. A pinion on the right-hand end of this shaft, where it emerges through the column of the machine, meshing with a gear on the cam-shaft *N* comprises the means of oscillating the work-holding chucks. This is accomplished through the action of cam *O* on shaft *N*. In this cam is a groove that guides a pin on beam *P* that extends through to the outer end of the machine as illustrated in Figs. 4 and 5 and in detail in Fig. 7. There is a rocker arm at the end of this beam that reciprocates shaft *Q* through a yoke and bushing. Now referring to Fig. 6, the inner end of shaft *Q* may be seen. This shaft marks the center of the four spindles and serves as a means for indexing them as will later be explained. A spider *R* is keyed to the end of the shaft *Q* and advances with it, under the action of beam *P* and the rocker arm just mentioned. Each of the four arms of the spider extends to one of the four work-holding spindles of the machine, and by means of yokes and collars on the spindles they are advanced or drawn back under the action of the spider. In order to make the oscillating action more clearly understood, Fig. 8 is presented. This represents the details of one of the chucks that are shown in general in Fig. 7. In Fig. 8, the spider arm for this spindle is indicated at *R*, governing the reciprocation of spindle *A*. The ball is shown at the end of the spindle at *D*. It is oscillated when spider *R* brings the spindle forward, causing sections *S* of the spindle to form a toggle joint as shown. This operation does not interrupt the rotation of the spindle, however, as

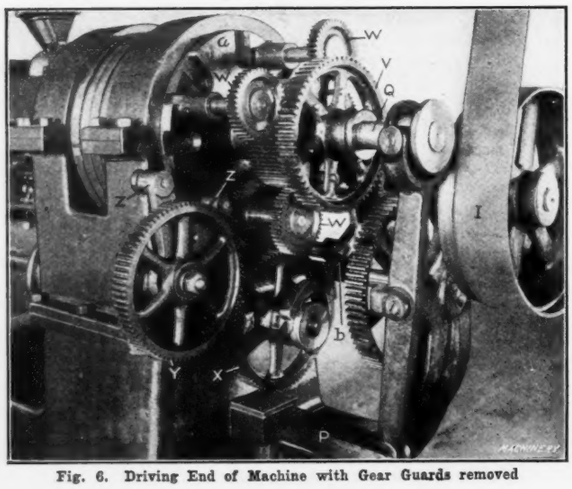


Fig. 6. Driving End of Machine with Gear Guards removed

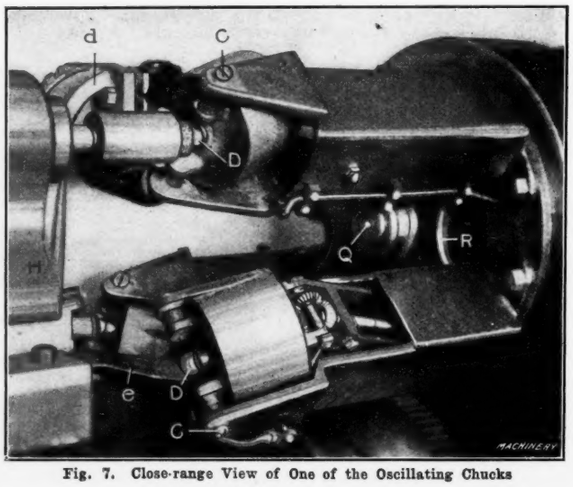


Fig. 7. Close-range View of One of the Oscillating Chucks

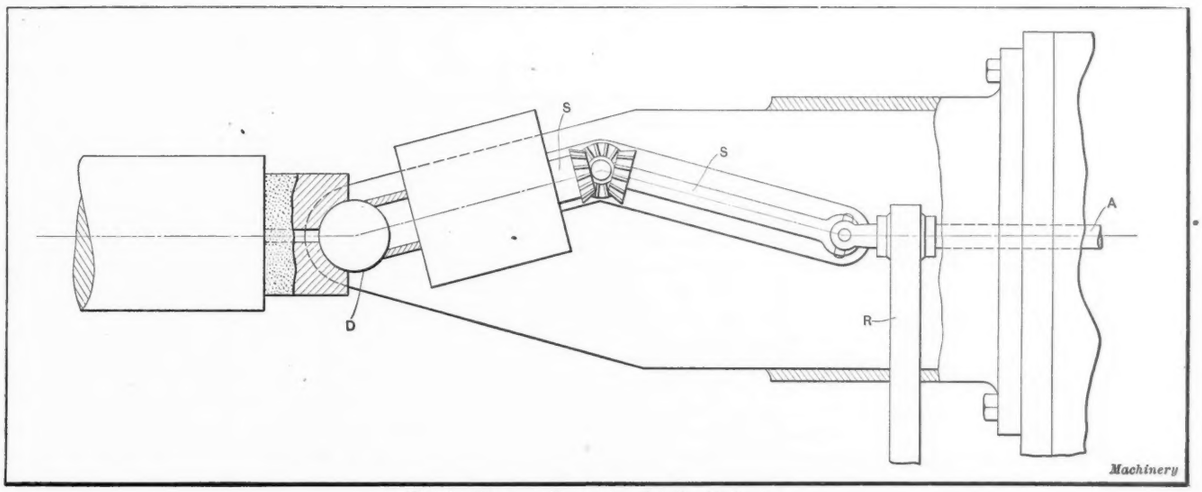


Fig. 8. Diagram illustrating Spindle Mechanism

by means of bevel gearing at the toggle joint the motion is carried through to the ball which may be seen on the chuck at *D*. This toggle motion is identical on all four chucks, being operated in the same manner for all four spindles as has been described and shown.

The Grinding Wheel Carriage

The manner of rotating and oscillating the balls while being ground having now been described, we may turn to the grinding spindle carriage above referred to. This is caused to advance for grinding the balls at one setting and then automatically retreat while the spindle indexing is taking place. In the face of barrel-cam *T*, Fig. 5, located on shaft *N*, is cut a cam-groove that guides a stud projecting downward from the bottom face of the grinding carriage. In accordance with the groove, the carriage, which is mounted on ways, is caused to advance and withdraw. The timing of the reciprocating agrees, of course, with the oscillating and indexing movements. The carriage is driven forward to exactly the same spot at each reciprocation, and to compensate for the wear of the wheel there are micrometer collars which may be seen at *U* on the ends of the grinding spindles. As a safeguard, the wheels are mounted with springs behind so that should a ball of too large a size be admitted to the machine by mistake, no damage will be done.

Method of Indexing the Spindles

We now come to an important part of the mechanism, namely, the indexing of the spindles. This is done by a modification of the Geneva motion and may be understood by referring to Fig. 6. Upon the end of the cam-shaft which extends back to the rear of the machine, there is a driving gear *X* which meshes with gear *Y* that is mounted on a stud extending from the column of the machine. Bolted to gear *Y* is a V-shaped arm *Z* that carries two roller studs that are spaced apart a distance equal to that between two of the eight slots in spindle carrier *a*. Arm *Z* being bolted to gear *Y* rotates continuously. At each revolution of gear *Y*, therefore, both of the pins on arm *Z* come into use, engaging successive slots in plate *a* and causing this plate, and consequently both spindles, to make an exact quarter turn. A locking bolt is provided for holding the spindles when not being indexed. This is not shown in the illustration. The object in using this double form of Geneva motion is to economize in the space between the center of plate *a* and the center of gear *Y*. It is essential that the oscillating and rotating motions of the spindles cease while the indexing takes place. This is accomplished by having a small cam on the end of gear *X* that, through a lever *b*, throws out clutch *L*, shown in Fig. 5, on the driving shaft. The throwing out of this clutch causes all motion to cease that would otherwise be transmitted by gear *K* through the gear train to the four spindles. As soon as the indexing has been completed, this clutch engages again.

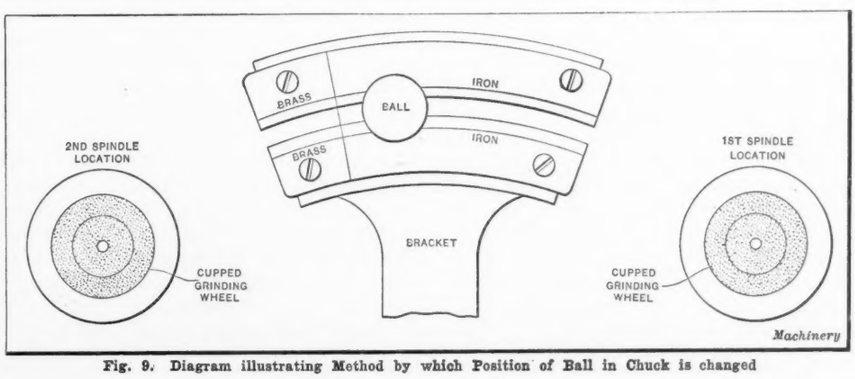


Fig. 9. Diagram illustrating Method by which Position of Ball in Chuck is changed

Holding and Controlling the Balls while Being Ground

The holding of a perfect sphere by a small section of its surface is a difficult matter, but is well done on the Tolford machine by employing magnetism. Referring to Fig. 5 at *f* may be seen four commutator rings to which electric current is conducted. A switch *g* provides for shutting off the current. By means of brushes, the current is carried to each of the four spindles, terminating at the magnetic ball-holding chucks.

The Operation of the Machine

Having now seen how the various functions of the machine operate, we can turn to the operation of the machine on a "batch" of balls. The balls are placed in the hopper, which is shown at *c*, and perhaps can be best seen in Fig. 5, although it is shown in Fig. 4. The balls are carried to this hopper by means of a simple endless bucket chain which was not on the machine when the photographs were taken. After dropping down the chute, the balls are fed, one at each indexing, to the chuck on the spindle that may be seen at the end of chute *h* in Fig. 5. They are fed one at a time by using the familiar powder flask feed in which a gate is dropped down behind the feeding of each ball. The ball *D* in Fig. 5, after being held on the magnetic chuck, is carried with the indexing spindle to the upper position which is the first of the grinding positions. Here at the upper position, visible in Fig. 5, it is oscillated and revolved in connection with the end-working grinding wheel previously described. After the grinding time on this pole has elapsed, indexing brings this ball to the upper position at the opposite side of the machine, visible in Fig. 4, where it comes into contact with another end-working wheel. In order to work successfully, the timing of the indexing, oscillating, grinding carriage, and other movements must be absolutely accurate. All of these timed operations are controlled from cam-shaft

N, the indexing taking place every twelve seconds. The carriage holding the grinding wheels retreats just before the indexing period, and returns as soon as the indexing is done.

Changing the Location of the Ball in the Chuck Between the Grinding Operations

At the time of this indexing, however, an important operation takes place by means of which the position of the ball in the chuck is changed, thus presenting a new face to be ground. By referring to Fig. 7, in connection with the line illustration Fig. 9, an idea of how this is done may be secured. In Fig. 9 the spindles and ball-holding chuck have been omitted for clearness. There is a curved bracket *d* directly between the two grinding spindles and in the arc that the balls must traverse when the spindles index carrying the balls from one grinding operation to the next. On the face of this bracket there is a curved path or groove, formed of separated strips of metal. As shown in Fig. 9, the strips that form this path are of iron on one end and of brass on the other end. The steel strips are magnetized, the switch being shown at *i* in Fig. 5. By shifting the strips, the demagnetizing point may be changed at will. The path on the bracket is so located that when indexing, the ball just grazes the path groove. As soon as the spindle and its ball reach this bracket in the process of indexing, the magnetism in the ball-holding chuck is automatically cut out, and the magnetized path in the bracket attracts the ball. Thus the ball tends to cling to this path while it is passing, and though the grip of the chuck is broken, the ball is still loosely held in position, and the indexing causes it to turn on its axis while passing this path. By the time it has reached the "brass" section of the path, it has rolled slightly in excess of one-half revolution. Just as the ball leaves the magnetized portion of the path in the bracket *d*, magnetism is resumed in the ball-holding chuck, and as there is no counteracting attraction in the "brass" part of the path, it is picked up again by the chuck ready for the next grinding position. After undergoing another grinding, indexing takes place again, carrying the ball to the lower position shown in Fig. 4. This is the ejecting position, and, magnetism being cut off from the chuck, again the spring finger *j* causes the ball to be thrown out of the chuck and into a box from which it is taken by the automatic feed (not shown), and sent around the machine again. Before the spindle reaches the next position, which is the loading position, magnetism is again taken on by the chuck, and it is ready to receive a new ball from the powder flask feed.

It will be remembered in the description of the operation of the machine, it was stated that there were certain periods during which the magnetism was automatically released from the chuck. These are two in number at each indexing; one at the time the ball is being changed in its position in the chuck between the indexing, and the other at the time of ejection from the machine. This is accomplished by having fiber inserts in the commutator rings *f* so that the current is cut off while the brushes are passing over these sections. The current of the commutator rings is controlled by the switch *g*, and the current that is in the path bracket is controlled by switch *i*.

The grinding wheel spindles rotate at a speed of 15,000 R. P. M. and the ball-holding spindles turn at an approximate rate of 100 R. P. M. The oscillation of the chucks takes place at every indexing, or once every twelve seconds. At each grinding about 0.001 inch is removed from the section worked upon. In all, about 0.003 inch is taken from the balls in rough-grinding, and to do this the balls pass through the machine on an average of four times.

It is recommended that these machines be used in pairs; that is, one machine for rough-grinding and the other for finish-grinding. The machine is most efficient when working on balls three-eighths inch diameter and over, although, of course, a smaller sized machine would take care of the small balls equally well. It is claimed by the designer that in addition to turning out balls with a better finish, it will, on account of its more efficient grinding principle, grind balls much faster; it takes less power to operate; the cost of wheels is very low, owing to the fact that a one-inch wheel is of ample size for most commercial sizes of balls and the wheels do not wear out of true.

RESPONSIBILITY OF DIRECTORS

BY CON WISE

We have lately been seeing some of the results of directors failing to direct a railroad. It brings up the old problem of who shall manage any enterprise—whether it be commercial, industrial or what not. It has been pretty generally understood that an individual superintendent, or manager, can not be held responsible for results unless he is put in a position where he can do about as he pleases. The most important function of the board of directors was agreed to be the selection of that manager. Just now we are running on the other tack. We feel that the directors are trustees in whose hands the stockholders and the general public which the corporation serves have placed the management of the concern, and that they are responsible for everything done by those men whom they select to do the actual work. If this is to be the rule it will necessitate a very decided change in another way. If directors are to direct, it is necessary that they should know what they are directing and how to direct it. That is, every man on the board should be competent to step in and take the place of the manager. Not only should each one be competent, but he should be sufficiently conversant with what is actually going on so that he can step in at any time.

As we see this, it means that boards will have to be made up of men that are on the job in responsible positions, instead of being made up of financiers. If it does produce that result it cannot help but be a step in the right direction so far as the legitimate purpose of the corporation is concerned. There will be less violent fluctuation of the value of stock for the benefit of those on the inside who are now so easily able to make a "killing" whenever they feel the need of a little extra pocket money. It will produce more or less hesitancy about investing on the part of those whose idea of profits is to take something away from someone else, but we cannot feel that that would be an irreparable loss. The great bulk of investment is held by people whose income is dependent on the steady return of dividends, and not on the fluctuations of the market. These people, and they are really the ones that hold the money of the nation, will feel much safer in making their investments if they know that the mechanical industries of the country are in the hands of mechanics, and the agricultural interests in the hands of farmers.

The capital stock of machine tool manufacturers has never been widely distributed among the general public for the two following reasons among others: first, that no serious attempt has been made to distribute it; and second, that it has always been in the hands of people who would not resort to the methods of exploitation that have been the common practice with railroads and some other commercial ventures. If the wild cat element can be taken out of these latter securities, as we believe that popular opinion will make necessary, there will be a much better chance for the purely industrial stocks, because then they will all be on one basis. The manufacture of machine tools is always bound to be more or less seasonal. There are two reasons only for buying machinery, one because of improvements which necessitate throwing out the old; the other, the advent of new business. Machine tools practically never wear out. That is, wear can be repaired very easily and very cheaply if taken in time. New business only comes when all business is advancing steadily. Until we reach the millenium we are not likely to strike that condition. In the meantime the only way that the business can be stabilized is to carry a stock during dull times, and that means the use of more capital, which cannot be easily obtained while other lines of business make such plausible claims for its use.

* * *

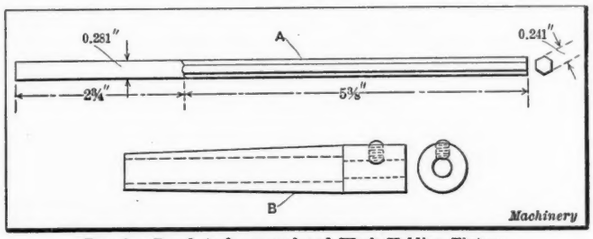
It has been estimated that out of the $100 paid by a first-class passenger for a trip across the ocean, $6.50 goes toward paying the salaries and wages of the officers and crew of the vessel; $8.25 to provide food; $4.75 to insurance; $1.75 to repairs; $10 to pay port duties and other expenses while in port; $2.75 to agents; $3.50 to administration and main office expenses; $25.50 to pay the coal bill; $9.00 for depreciation of the vessel; and the remainder, about $28, constitutes the profit of the company.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

GRINDING VS. MILLING

Many articles on grinding vs. milling have appeared in the different mechanical journals but most of them have dealt with the grinding of cast iron on improved types of surface grinders or disk grinders. It is a generally recognized fact that a great deal of time and money has been lost by those manufacturing plants that have failed to take advantage of the improved method of production which grinding machines offer for handling certain classes of work. As an example of this, I may mention one particular job on which a saving of



Drawing Punch to be ground and Work Holding Fixture

from ten to twelve hours per piece was effected through the use of the grinding machine. The part shown at *A* is a drawing punch used for producing seamless brass shells. It is necessary for this punch to be of a uniform hexagon shape and to have a taper of 0.001 inch in its entire length, in order to make it possible to strip the drawn shell from the punch. The stripping operation is performed by having the lower edge of the die engage the shell and strip it from the punch on the up-stroke of the press.

The method formerly employed for making these punches involved turning, milling, filing, hardening, straightening, grinding and lapping, in the order named. Owing to the slenderness of the punch, this work had to be handled very slowly and each punch cost about $5. Anyone who is familiar with the operation of drawing seamless shells will realize that the expense connected with using such costly punches would be considerable. Punches are seldom worn out. No matter how careful the press operator may be, he is likely sooner or later to put a shell on the punch in a way that causes the punch to be broken. The grinding method now used for making these punches has reduced their cost from $5 to 29 cents each. As the punch comes from the grinder, it is merely necessary to stone the corners and polish to give it the required finish. The only tools necessary for this purpose consists of the work-holder shown at *B*, and an index mechanism arranged on the No. 2 Landis universal grinder on which the punches were ground.

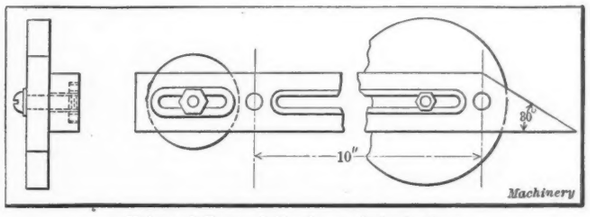
The arrangement of the index mechanism used for grinding these punches was as follows: The headstock spindle was taken out of the machine and six 7/16-inch holes were drilled in the periphery of the pulley used for driving the spindle when the machine is employed on chucking work. A milling machine with a vertical attachment and dividing head was used for locating these holes accurately. The holes were bushed to ¼ inch in diameter, after which the spindle was placed in the head of the machine and adjusted ready for use. The headstock was next taken to the drill press, where a hole was spotted in the headstock casting through the bushed hole in the pulley, which is of hollow construction and extends backward over the casting. When the spotted hole was drilled and bushed and the index pin made, the grinding of the punches was carried out with comparative ease.

The punches were made from letter M drill rod which was cut off to the required length and centered in a screw machine, after which the hardening and straightening operations were performed. The shank was next ground to a diameter of 0.281 inch, using a back-rest to provide the necessary support. The hexagonal end of the punch was then ground, using the special work-holder *B* which fits in the taper hole of the spindle and supports the work very rigidly. A 60-grain grade P aloxite grinding wheel was used, and it was found possible to rough-grind each side of the hexagon to within a few thousandths of the required size without springing the work. Two finishing cuts were then taken on each side of the hexagon. The work was finished complete without being taken out of the machine and about fifteen minutes was required to complete each punch. As the periphery of the wheel was used, each side of the hexagon was naturally a little concave, but this error was found to be negligible when using a wheel 10 inches in diameter. For the particular work for which these punches are used the concave sides are slightly advantageous, as the corners are brought up sharper than would otherwise be the case. The saving effected by this method of making the punches may seem unusually large to some readers, but if they will try making a similar punch by the two methods they will soon see that no exaggeration has been made in stating the case.

Newark, N. J. JOHN MAHON

PRECISION METHOD OF MEASURING ANGLES

Guy H. Gardner's description of precision methods of measuring angles, which was published in the October number of MACHINERY, seems to call forth one or two criticisms. If the scale used does not have a perfectly sharp corner in contact with the work, an error will be noticed. If the corner of the scale is bruised even enough to allow it to drop 0.001 inch, the resulting error in the angular measurement would amount to about 30 seconds. This is sufficient to emphasize the importance of the criticism without requiring further comment. It also appears that the clamped scale and indicator method shown at *B* in Fig. 2, could be applied in the case of the sine-bar by clamping it at the required angle, as is done with the scale. Perhaps a better method would be to clamp it high enough from the surface plate to enable the work to be inserted between the sine-bar and the plate.



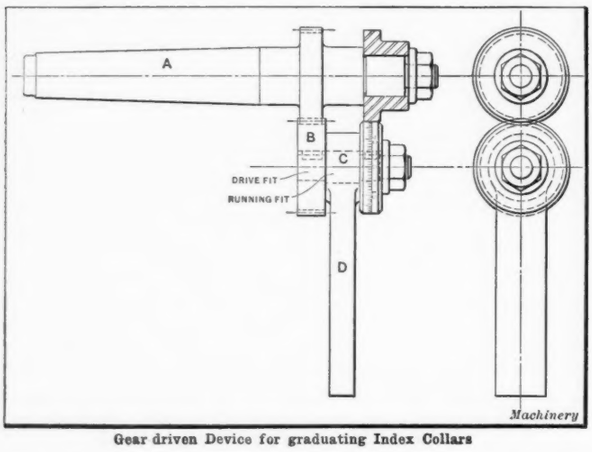
Universal Form of Sine-bar and Angle Gage

Many ingenious methods of obtaining and measuring angles have been described in MACHINERY, but I believe no one has described the universal gage shown in the accompanying illustration. It will be seen that this is a sine-bar provided with two slots and two screws for clamping disks of various diameters to obtain different distances between their centers. The bar is provided with one angular end which is found convenient in many cases. The slots are also found useful for clamping the bar to an angle-plate. The length of the bar will, of course, be decided by the character of the work, but having a distance of 10 inches between the buttons makes the calculations particularly easy to handle.

Turtle Creek, Pa. WILLIAM S. ROWELL

A GRADUATING DEVICE

The accompanying illustration shows a device for graduating index collars that has given very satisfactory results. It will be seen that the mandrel *A*, which is fitted to the lathe spindle, holds the work at its end and has a gear cut

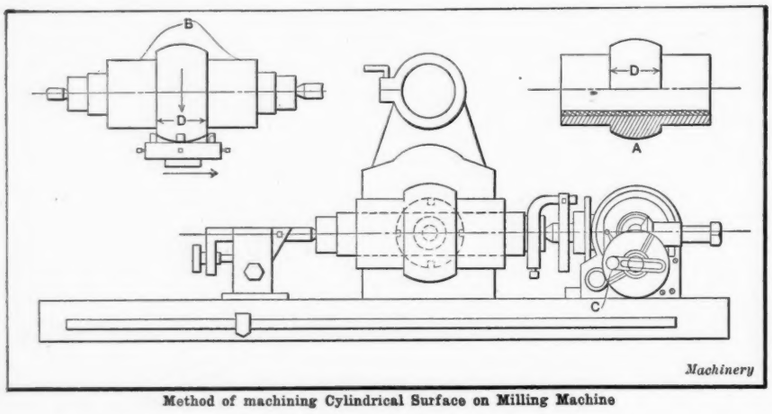


Gear driven Device for graduating Index Collars

from the solid metal. The gear on the mandrel meshes with the gear *B* which is keyed to the stud *C*, mounted in a holder *D* that is carried in the toolpost of the lathe. The graduating roll is keyed to the stud *C* and fed into the work, the graduation lines and figures being slowly rolled into the index collar in this way. The advantage that the geared drive for the graduating roll has over frictional contact of the roll and work, is that there is no possibility of the relative positions of the work and the graduating roll shifting, which would result in either impairing the accuracy of the graduations or entirely spoiling the work. H. F. D.

TURNING A BALL WITHOUT SPECIAL TOOLS

Not long ago, while working in a small jobbing shop, I was called upon to machine twelve self-aligning bearings of the type shown at *A* in the accompanying illustration. It was desired to produce the spherical surfaces as quickly as possible and with as small an outlay for special tools as was consistent with the necessity of holding the work within a limit of 0.0005 inch. The spherical surface of these bearings was 10 inches in diameter.



Method of machining Cylindrical Surface on Milling Machine

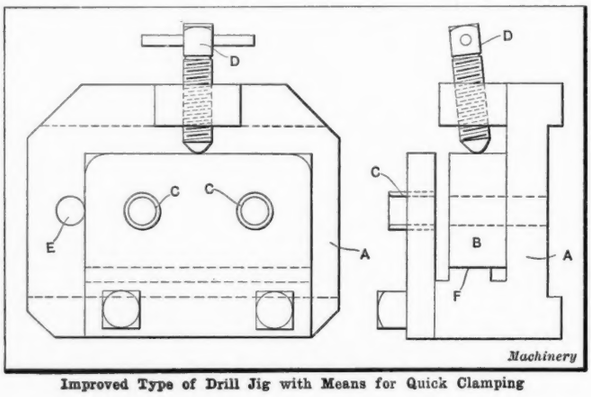
In handling this work, the first step was to babbitt the bearing and bore it to the required size. The work was then mounted on a mandrel and after removing the scale, the ends of the spherical bearing were faced and the shoulders *B* turned to within 1/64 inch of the required size. The work was next set up on the index centers of the milling machine, and while the cutter revolved in the direction shown by the arrow, rotation was also imparted to the bearing by means of the index crank *C*, the direction of rotation being shown by the arrow.

The accuracy of the spherical surface produced by this method depends upon the alignment of the center of the sphere with the center line of the milling machine spindle. Care should be taken to determine the alignment of these centers before the work is started. After finishing the spherical surface, the shoulders *B* were finished on the lathe. The cutter used for milling the spherical surfaces was of the inserted-tooth type and was made in the shop where the bearings were machined. The distance between opposite teeth of the cutter should be a trifle greater than the dimension *D* of the spherical bearing, but the distance between the teeth should not be great enough to allow them to strike the shoulders *B* on the bearing before the spherical surface has been turned to the required size. The results produced by this method proved entirely satisfactory, and the work was accepted without question.

New Haven, Conn. GEORGE SLIDER

DRILL JIG FOR RAPID PRODUCTION

In the September, 1914, number of MACHINERY, a short article was published entitled, "Drill Jig for Rapid Production." The accompanying illustration shows a jig for the same purpose, that is similar in construction but handles the work more rapidly. The base *A* of the jig is made of cast iron and arranged to suit the requirements of the work *B*. The bushings *C* are held in a bushing plate in the usual way.



Improved Type of Drill Jig with Means for Quick Clamping

The clamping of this jig is a simple matter and can be done very rapidly. One-half turn of the screw *D* clamps the work in the chuck. The 3/16 by 2 inch steel pin driven through the head of the screw enables it to be easily turned with the fingers. In loading the jig, the work is brought into contact with the steel pin *E* and face *F* on the jig, after which the screw *D* is tightened and the work is ready to be drilled. As the chips usually fall on the base of the jig when removing the work, they must be removed before another piece is put in place. An old brush can be used to clean out the chips from the jig.

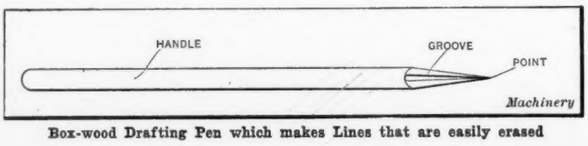
Toledo, Ohio. WILLIAM H. WOLFGANG

SPECIAL WOODEN DRAFTING PEN

It was necessary to send out good clear prints of a drawing which was expected to be changed later. To meet these requirements, we used a pen made of box-wood, sharpened down to a point and with a groove at one side as shown. The use of this pen saved a great deal of labor in erasing, as we found it much easier to erase lines made with it than would have been possible where an ordinary steel lettering pen was used. It is surprising how clearly a pen of this kind will write and the length of time that it will hold its point.

Lynn, Mass. R. F. POHLE

[The use of box-wood pens of the type referred to is not unusual in drafting-rooms, where they are found to give ex-

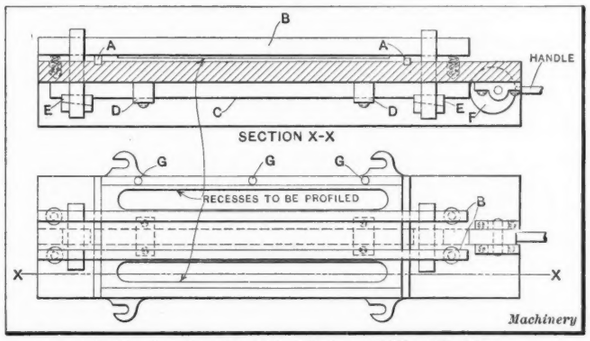


Box-wood Drafting Pen which makes Lines that are easily erased

cellent satisfaction for certain classes of work. Mr. Pohle's reference to the ease with which lines made with such a pen can be erased is new to us. The explanation is evidently found in the fact that the box-wood pen does not cut into the surface of the paper or tracing cloth as an ordinary pen will do. As a result, it is merely a case of removing the ink from the surface of the tracing cloth or paper instead of having to get it out of a diminutive channel made by the pen-point.—EDITOR.]

CLAMPING DEVICE FOR THIN WORK

A simple and useful clamping device for holding thin plates that are to be milled or profiled is shown in the accompanying illustration. This consists of a cast-iron base provided with four lugs for fastening it to the table of the milling machine. Referring to the cross-sectional view, it will be seen that



Device for clamping Thin Work on Milling Machine

stops *A* are provided to engage the ends of the work. If shorter pieces are to be machined, other slots can be cut in the base of the fixture and the stops placed in them. In this way, the fixture can be made to accommodate many different lengths of work.

The two clamp bars *B* are forced down onto the work through the action of the slide bar *C* which is carried in two bearings *D* and provided with two wedges *E*, forced forward by means of the eccentric *F*. When the handle that turns the eccentric is brought to the vertical position—which releases the wedges *E*—a spring pulls the slide bar *C* back, allowing bars *B* to be raised by the small springs under them. The finished plate can then be removed and a fresh plate put in place. Caps are placed over the springs that raise the clamping bar, to exclude chips. The pins *G* also act as stops for locating the work sidewise. This clamping device has been found particularly useful in profiling recesses in plates 1/8 inch thick and of different lengths.

Schenectady, N. Y. CHARLES SERTL

BABBITT BEARINGS

The purpose of this article is to describe a form of babbitt spindle bearing that has been found to give exceptionally satisfactory results and to explain the method of procedure followed in molding and machining bearings of this type. Fig. 1 shows one of the half bearings, and it will be seen that flanged ends are provided to take the spindle thrust. The bearing is finished all over.

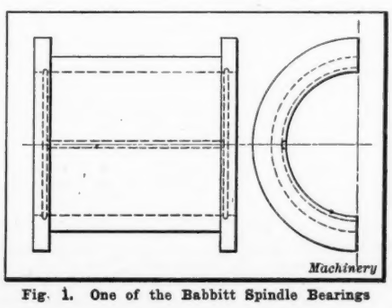


Fig. 1. One of the Babbitt Spindle Bearings

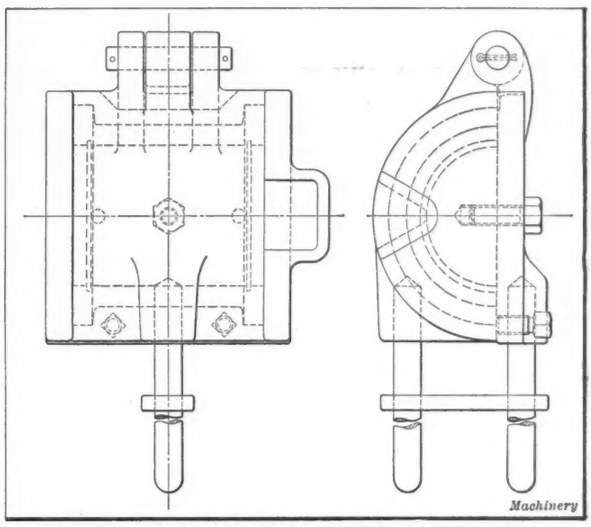


Fig. 2. Mold in which Babbitt Spindle Bearings are made

The mold for making these bearings is shown in Fig. 2. It will be seen that it is arranged with a semi-cylindrical mandrel secured to the base by means of cap-screws. The cover is hinged and provided with a handle for opening and closing it; and there is a second handle in the base of the mold, connected to the first by a plate with holes in it, through which the handles are slipped to clamp the cover down on the mold. The two screws in the front edge of the base are screwed down against the cover to force the cover up in case it sticks so that it cannot be easily lifted by the handle. The pocket at one side of the base is used for pouring the metal into the mold; this pocket is fairly large and allows the metal to flow freely. As this bearing is to be machined after pouring, an allowance is made in the mold to provide 1/32 inch of metal for finishing on all surfaces that are to be subsequently machined.

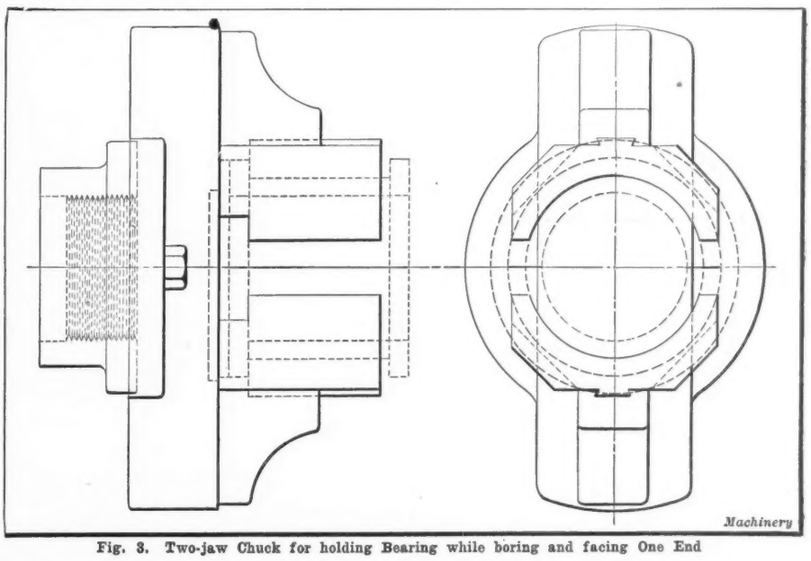


Fig. 3. Two-jaw Chuck for holding Bearing while boring and facing One End

After the metal has been poured and allowed sufficient time to cool, the bearing is taken to the trimming press where the riser from the mold is cut off. The bottom of the half bearing is then milled off, after which the bearing is bored, and turned and faced at one end. Fig. 3 shows a two-jaw chuck with special jaws for holding two half bearings in place while they are being bored, faced and turned on the lathe. After these operations have been completed, two of the half bearings are mounted on a mandrel of the form shown in Fig. 4, ready to be turned and faced at the other end, and to have the outer surface finished. The bearings are first held on the mandrel with clamps of the form shown in Fig. 5 ready to have the end faced and turned, the nut and ring being set back to pro-

vide for handling this operation. The nut is then screwed forward against the finished end of the bearing and the clamp is removed to provide for facing the inside edges of the flanges and turning the outer surface of the bearing. After this work has been done, the bearing is completed and is ready to be assembled on the machine in which it is used.

W. P. W.

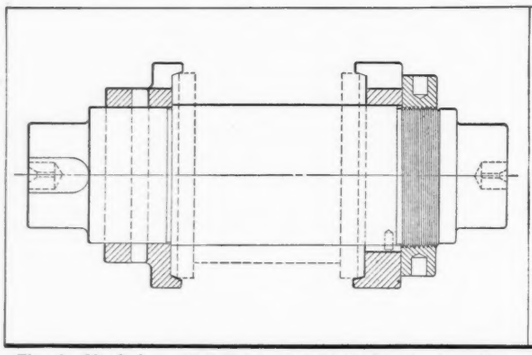


Fig. 4. Mandrel on which Bearing is held for Turning Operation.

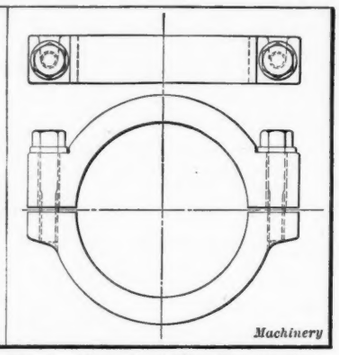


Fig. 5. Clamp for holding Two Bearings

DIMENSIONING TAPER GIBS

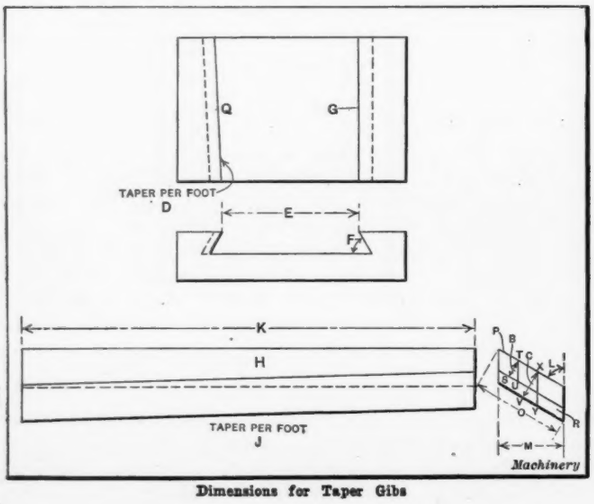
Taper gibs, although a very common detail of machine design for taking up wear caused by side pressure on the ways of machine tools, seem to be a feature to which too little time and attention has been given. Articles have appeared in the different mechanical publications from time to time touching upon the dimensioning of this type of gib so that its greatest width would be shown at a glance, which would assist in the preliminary operations on the rough casting. This seems to be a step in the right direction, but it is not enough. The methods in use at the present time, in many cases do not give the men in the shop all the information which a machine drawing is supposed to impart.

The dimensions in the accompanying illustration show quite clearly the point made. The dimensions on the slideways are correct and give all the information necessary for the machining of this part: *E* shows the width at the narrowest point; the taper per foot *D* shows the amount the piece of work must be set over on the table of the machine after the side *G* has been finished; and the angle *F* shows the angular setting of the tool-head to bring the slideways to their correct proportions.

The gib *H*, which is to be inserted between the slide and the above-mentioned ways, is the part that is here under consideration. The dimensions *J*, *K*, *L*, *M*, *B* and occasionally *O* are those commonly given. If the taper per foot of the gib at right angles to the surface *P* were the same as the taper per foot of the line *Q* as given in the illustration of the slideways, these dimensions would be all that would be required; but it will be found that if in the machining of the gib on its sides *R* and *P*, it is thrown up at one end the amount shown by *J* for each foot of length, it will not fit into its position by a considerable amount, which increases as the taper per foot is increased. This is the point which is many times left to the shop foreman to work out. One reason why this feature is not brought to light more often is that a gib planing fixture is used, which has been correctly figured by the tool designer; but nevertheless the fact remains that the working drawings should give complete information, so that the shop man will have no figuring of any kind to do in case he has no jigs or fixtures to aid him. In other words, the dimension *C* is required.

It will be well to assume the dimension *B* to be ⅜ inch, the taper *D*, ¼ inch per foot as shown on the slideways, the gib length *K*, 12 inches, and the angle *L* 60 degrees. By figuring the triangles *STU* and *VXY* it will be found that the dimension *C* is not ⅝ but 0.591 inch. This article may bring forward a further discussion of this subject.

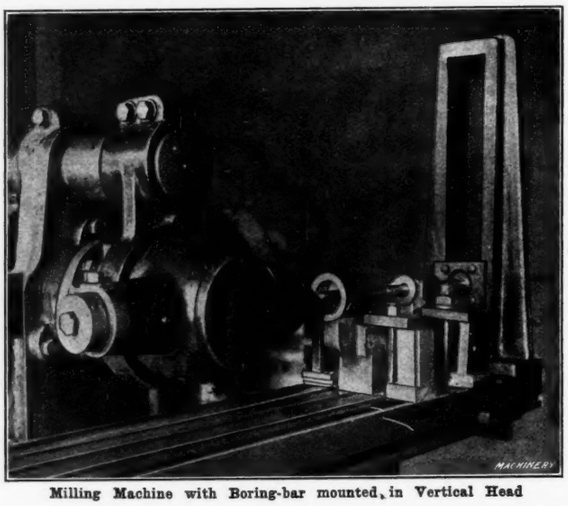
Central Falls, R. I. NORMAN R. EARLE



Dimensions for Taper Gibs

MILLING MACHINE BORING-BAR

The accompanying illustration shows a boring-bar which I recently made for use on a No. 3 Cincinnati miller. This bar is driven by a vertical head which is swung around to a horizontal position. An outer bearing for the bar is clamped to the column at the far end of the table, this bearing being adjustable for wear. The work shown clamped in position on the table is a frame for a quick-acting chuck. The piece is bored, counterbored and faced at a single setting.



Milling Machine with Boring-bar mounted in Vertical Head

Beverly, N. J. ARTHUR A. BAUMGARTNER

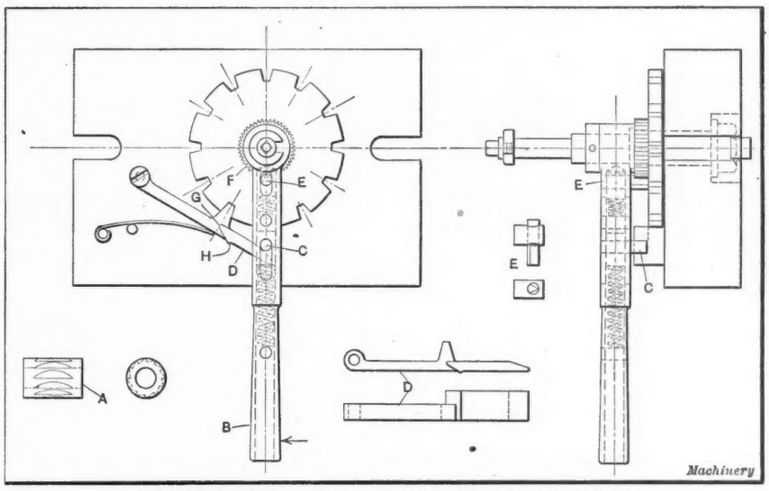
QUICK-SHIFTING INDEXING FIXTURE

The accompanying illustration shows a quick-shifting indexing fixture for use on a milling machine engaged in milling the teeth of ratchets of the form shown at *A*. The blank is held on the fixture by means of a screw and slotted washer, the arrangement of which is clearly shown in the side view. The operation is as follows: The handle *B* is moved in the direction of the arrow, causing the pin *C* at the end of the oblong slot in the handle to force the pawl *D* out of its slot in the dial. As soon as the pawl is out of the slot, the V-shaped pin *E*, which is kept engaged with the ratchet *F* by a spring, will cause the shaft to which the dial is keyed to revolve. When the pin *C* has reached the point *G*, it will

release the pawl, which is then thrown back into contact with the dial by a spring. As the dial continues to revolve, the pawl will drop into the next slot and locate the work for milling the next tooth.

In returning the handle, the pin *C* will travel on the opposite side of the pawl, and when left in the curve *H* the spring behind the pin will hold the pawl *D* securely in the slot in the dial. The spring behind pin *E* is made just stiff enough to keep the pin from slipping when the pawl is out of a slot in the dial. The teeth in the ratchet *F* were cut with an ordinary thread cutter. This fixture is used on a hand miller and the teeth in the blank are cut with an ordinary angular cutter. This system of shifting could easily be applied to a horizontal attachment, and by substituting a center for the stud and inserting a ball thrust bearing, it could be used instead of an index head where quick shifting is desirable. For those classes of work for which it is adapted, a fixture of this kind enables a very satisfactory rate of production to be attained.

Schenectady, N. Y. ALFRED WISTRUP



Quick-shifting Indexing Fixture used in milling Teeth in Ratchet

CREAM SEPARATOR USED AS AN OIL FILTER

In one of the Western states, there is a hydro power plant used for pumping water for irrigation purposes. The equipment of the plant consists of horizontal turbines which are direct-connected to centrifugal pumps. Part of one of these units is shown in Fig. 1. The stuffing-boxes *A* of the turbines are supplied with a constant stream of water regulated by a valve, for the purpose of sealing them so that water, instead of air, is drawn into the draft tubes through the stuffing-boxes. Incidentally, the water keeps the packing cool and lengthens its life. In order to be sure that the required condition is secured, it is necessary to supply a little more water than will be drawn in by the draft tube. Sometimes the water is very muddy and at other times it is clear, so that although the volume may have been very closely regulated, it occasionally happens that, without warning, the sediment in the pipes and stuffing-boxes is washed out and a stream of water flows along the shaft and enters the bearings *B*, displacing some of the oil in the reservoir and forming an emulsion with the rest.

The plan finally adopted to overcome this difficulty consisted of placing deflectors *C* on the shaft between the stuffing-boxes and the bearings. These deflectors were made of four circular disks of canvas stitched together, soaked in tar, and then bound onto the shaft with twine. With the pumping units equipped in this way, the water follows the shaft until it comes to the deflectors, when it is carried to their outer edge and thrown off by centrifugal force. The water is caught in a pan placed to receive it and carried off through a drain pipe. Before this plan was adopted, a considerable quantity of oil contaminated with water had been accumulated. Several forms of filters were tried in the hope of finding a method of separating the oil from the water, but none of these methods proved successful until someone suggested that a cream separator might accomplish the desired result. A second-hand machine was purchased and the results secured with it were all that could be desired. Not only was the oil and water perfectly separated but all of the grit and dirt was removed from the oil, leaving it in fit condition to be used again in the bearings. The method of procedure was to heat the oil and water until it was quite warm, then to pour it into the receiver of the cream separator and operate the separator just as it would be used for its regular function of separating the cream from milk.

A. J. HUMPHREY
Palisades, Colo.

Fig. 2. Cream Separator used for removing Water from the Oil

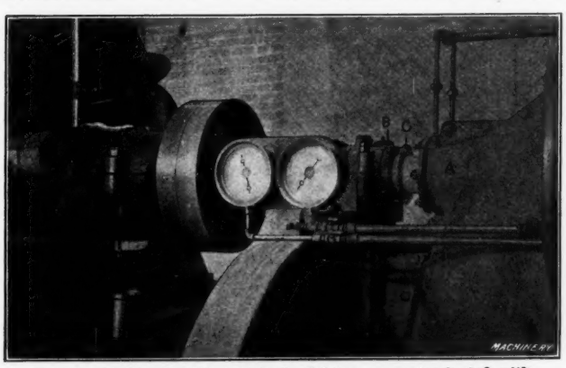


Fig. 1. Turbine Unit in which the Oil became contaminated with Mud and Water

COST DATA AND THE DRAFTING-ROOM

An editorial entitled "Cost Data Urgently Needed," published in the October number of MACHINERY, reminds the present writer of how little data is available in many drafting-rooms concerning the cost of material used in machine construction. Many draftsmen with good technical training cannot estimate the costs of materials and standard machine parts within even reasonable limits. This feature is given no attention in their college training and outside experience has taught them little in regard to the matter. When a designer determines the kind and quantity of material to be used, he should be guided to a considerable extent by balancing costs with comparative values.

The writer recalls an instance in designing a certain machine part, where unusual conditions made it desirable to specify a special material. After leaving the drafting-room, the blueprints passed through the usual routine in the superintendent's office, the estimating department, etc.; but after the machine was built, the designer learned that another

material had been substituted owing to the high cost of the material called for on the blueprint. As this material was not suitable for the service required of it, it was but natural that the result obtained was unsatisfactory. Such incidents would not be likely to occur if the "powers that be" realized the value of furnishing the drafting-room with complete data on the cost of all materials which are used in the factory.

Moore, Pa. JOHN LEAFSTROM

ACCURATE TAPERED PLUG GAGES

The writer was recently called upon to make a number of accurate tapered plug gages of various sizes up to 2 inches in diameter, and after studying the requirements of the work the following method was employed. The tool shown in Fig. 1 was made quite heavy to enable it to withstand the severe treatment which such tools frequently receive at the hands of the tool boy, etc. The two yokes *A* were rough-turned from machine steel forgings and the surfaces *B* were then ground on a surface grinder to insure having them parallel. The pieces *C* were made of tool steel; they were hardened, after which the surfaces *D* were ground and the surfaces *E* ground and lapped. The slots were made 1/16 inch larger than the screws, in order to provide for the required amount of adjustment.

This tool was used for gaging the tapered plugs while grinding, the method of setting for the proper taper in inches per foot being as follows: The block shown in Fig. 2 was

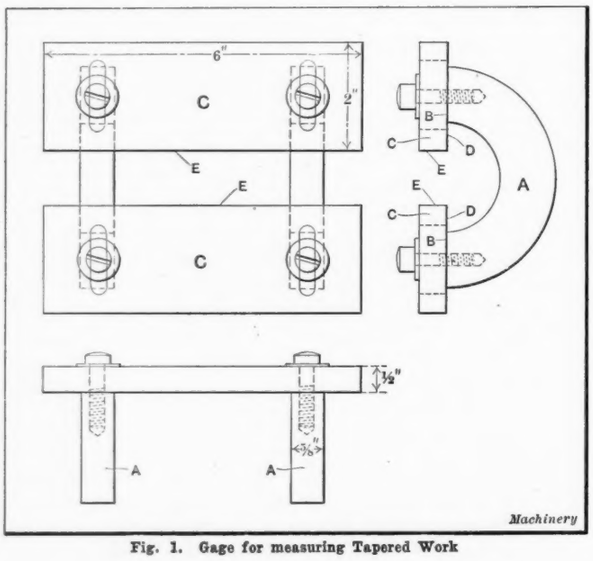


Fig. 1. Gage for measuring Tapered Work

made of machine steel with the holes of accurate diameter and accurately spaced between centers. Assuming that a plug is required with a taper of 1¼ inch per foot and 1 inch in diameter at the large end, it would be necessary to use accurate 11/16 and 1-inch plug gages in connection with the block. As the center distance of the holes in the block is exactly 3 inches, it will be evident that the difference in diameter of the plugs should be 5/16 inch to correspond to a taper of 1¼ inch per foot. In setting the gage shown in Fig. 1 all that is necessary is to insert the standard plugs in the block, Fig. 2, and then set the parallels to engage the protruding ends of the plugs. In case other tapers than 1¼ inch per foot are required, it would be necessary to make extra plugs with shanks to fit the holes in the block, and with the protruding ends of the proper diameters to correspond with the required taper.

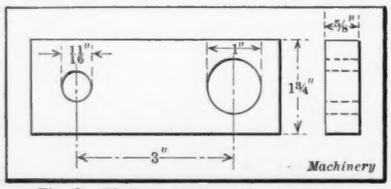


Fig. 2. Block for holding Plug Gages used for setting Gage shown in Fig. 1

The gage shown in Fig. 1 will be found useful in any grinding department as it is a simple matter to duplicate a special taper for a reamer or similar tool. A convenient method of using the device in a shop where the light is poor is to clamp a piece of cold-rolled steel in the vise and then clamp the taper gage to it. In this way the position may be adjusted in order to have the light fall in the required place. An adjustable stand to support this gage could also be made very cheaply. This would have a base to stand on the floor near the grinder and would be placed in the proper position to take advantage of the light. The use of such a stand would save the operator walking from the grinding machine to the bench for testing the taper on his work.

Newark, N. J. JOHN MAHON

SUGGESTIONS REGARDING THE DEVELOPMENT OF PATENTS

Articles frequently appear in the technical press describing the difficulties encountered by inventors of limited means in perfecting their ideas and getting them adequately protected by patents. It would doubtless be to the interest of this class of men to know that there are a great many ideas constantly being worked out by engineers of unquestionable integrity, and if the embryo inventor knew that there are capable engineers ready to help him with good sound advice, there would be a smaller number of patents granted each year and the patents granted would be on ideas that had actual value. There appears to be a feeling among inventors of limited means that the service of a mechanical engineer is beyond their reach; and as a result, such inventors seek the advice of men who are not fully qualified for the work, but appear to be the best obtainable under the circumstances.

It might be of interest to the man with an idea which he wants to develop and patent, to know that the services of a high-grade, conscientious engineer are not beyond his reach; that if he submitted his idea for the consideration of such an engineer he would get the same class of service that is rendered to a large corporation, and that he could depend on such an engineer to give him fair treatment and reliable advice at a moderate cost. Furthermore, if such an engineer tells him that his idea is impractical and not worth patenting, he can take it for granted that the engineer knows what he is talking about and that he is really working in the interest of his client when he gives him an unfavorable opinion. On the other hand, if the engineer's report is favorable, the inventor may rest assured that he is not being guided by mercenary considerations when he recommends changes in design, for it is up to the inventor to adopt the suggestions or reject them. It is regrettable that our patent laws are so flexible that unscrupulous persons are able to take advantage of inexperienced inventors and "get away with it," but until the laws are changed, the writer's advice to the inventor is to consult a reputable mechanical engineer and at least get his opinion concerning the value of the idea before proceeding to obtain a patent on it.

Indianapolis, Ind. FREDERICK C. FRANK

HARDENING HIGH-SPEED STEEL TOOLS

Of all the different methods for protecting the cutting edges of high-speed steel tools during the hardening process, none have proved more satisfactory or given better all-around results than that recommended by the Vanadium Alloys Steel Co. for the treatment of "Red-Cut" cobalt high-speed steel, this information being published by the company's selling agents, McKenna Bros. Brass Co., Pittsburg, Pa. When one stops to consider the delicacy of the cutting edges of such tools as formed cutters, dies, taps, etc., and that the cutting edges of such tools scale off less than 0.001 inch in the hardening process, if treated according to the following method, information on this subject will be recognized as a matter of vital importance.

Before entering upon a discussion of the method which it is the purpose of this article to describe, it will be of interest to know that it has been found to give equally good results when treating other high-speed steels such as "Novo," "Rex A-A," etc. The method of procedure is as follows: First remove all scale from the steel and clean it from oil, grease, etc. Then

while the tool is perfectly cold, immerse it in water and next roll the wet tool in powdered boric acid. After this has been done, pre-heat the tool slowly to a temperature of about 1200 degrees F., remove it from the furnace at this temperature and again roll it in powdered boric acid. This treatment results in completely covering the tool with a coating of boric acid which serves to protect the surface of the steel from the decarbonizing action of the air. The tool is then replaced in the furnace and brought quickly to a temperature of 2300 degrees F., after which it is quenched in an oil bath.

In cases where it is necessary to draw the temper, the best results are obtained by employing a temperature of 900 degrees F. and permitting the tool to cool in the open air. The coating of boric acid that remains on the steel can be removed by soaking it in fresh cold water for a short time. Great care should be taken to have the tool perfectly cold before immersing it in water to remove the boric acid; otherwise, the tool may crack. These instructions apply particularly to the hardening of milling cutters, twist drills, taps, dies, etc., made of "Red-Cut" cobalt steel.

As an example of the efficiency of this method in treating other classes of high-speed steel, the following instance may be cited. A tap made of "Rex A-A" steel was heated in a gas furnace to 2350 degrees F. instead of 2250 degrees F., which was the proper temperature to employ; but the tap came out just as clean and free from scale and decarbonization as other taps of the same size and made of the same steel, which were heated to the correct temperature before quenching. It will be evident that in using this method for the treatment of other classes of high-speed steel, suitable hardening temperatures and drawing temperatures must be employed, as these temperatures naturally vary with different steels. A.

NOISE AND INDUSTRIAL ACCIDENTS

I have just read a book dealing with the subject of industrial accidents and their causes, in which the following causes are mentioned: poor natural or artificial illumination, overcrowding of equipment with insufficient space for the operators, slippery floors, inexperience or ignorance in operating machinery, carelessness and lack of discipline, unsuitable clothing, over-work and fatigue, poor ventilation and intoxication.

Noise is a very important cause of industrial accidents that is not mentioned in the book referred to. Noise and fatigue might properly be coupled together, because fatigue is often the direct result of noise. Be this as it may, it is certain that noise is often the direct cause of accidents, a typical case being that in which a machine slipped from an overhead crane and fell onto a workman. The crane operator saw the machine slipping and shouted to the workman but was unable to make him hear because of the noise in the shop.

Steps toward the elimination of unnecessary noise are now being taken by the management of progressive industrial plants. Not only is this a means of providing for the safety of the operators, but experience has shown that more work can be done in a quiet shop, that there are apt to be fewer mistakes made, and that the quality of the work will be improved. These are certainly points that the up-to-date manufacturer cannot afford to overlook. N. G. NEAR

A SAFETY LATHE DOG

In the October and November, 1912, numbers of MACHINERY, two articles appeared describing various forms of dogs and drivers. A number of excellent devices for this purpose were described, but the accompanying illustration shows what the writer believes to be a dog fully as good if not better than any of those shown in connection with the article referred to. Fig. 1 shows front and rear views of the dog and a detailed design of the parts is shown in Fig. 2. Referring to these illustrations, it will be seen that the socket type of safety set-screws is used, these screws being tightened by a wrench in the usual way so that there is no chance for the heads to strike the operator's hands or catch his clothing. The tail of the dog extends out at the back of the plate where

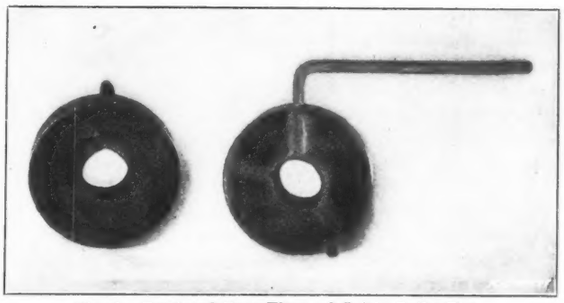


Fig. 1. Front and Rear Views of Safety Lathe Dog

it is out of the way. These dogs have been used for several years in the machine shops of the Oliver Iron Mining Co.,

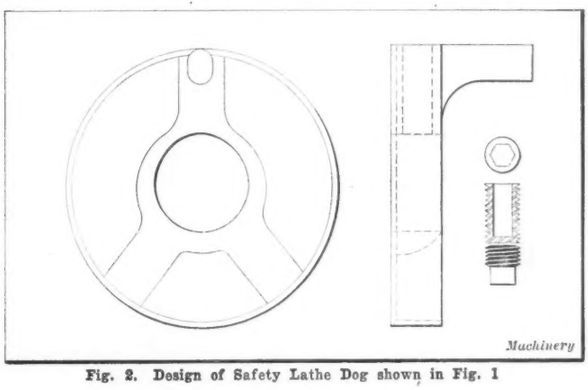


Fig. 2. Design of Safety Lathe Dog shown in Fig. 1

of Norway, Mich., where they have given very satisfactory results.

Norway, Mich. HENRY HOSKING

ECONOMICAL SHOP LAYOUT

Manufacturers are realizing more and more the value of economical routing of material through the shops; and although competition may be forcing the realization of its necessity on them, the tendency toward maximum production at minimum cost is demanding a careful location of machinery. Owing to this fact the writer would like to make the following suggestion. When the plans of the building or buildings are completed the task of planning the proper location of machinery begins, which involves considerable thought and juggling of machines on paper. It is obvious that this process of locating machines is far simpler than moving the machines themselves when they have been set up in working order, but the method necessitates the gathering of considerable data relative to the space occupied by the machines and the space required by the operators. When these data are once gathered, it again requires valuable time in the drawing-room to prepare scale drawings of each machine on separate pieces of paper.

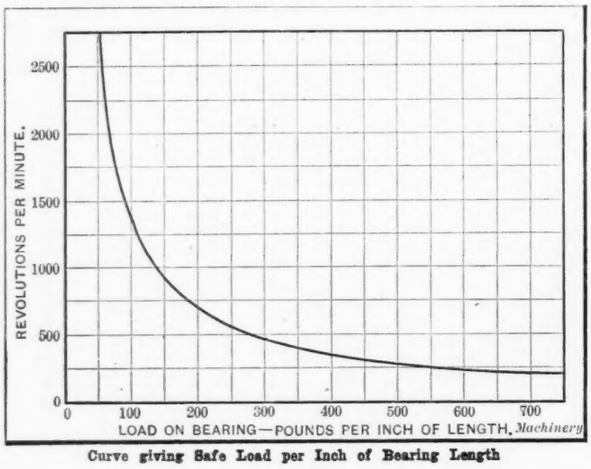
If machine tool manufacturers in compiling their catalogues would devote one page to small outline illustrations to a scale of ¼ inch to the foot, showing the space required by their machines, the space required by the operators, and also giving in small print the name and style or number of the machine, it would be a great time-saver, as the planner of a proposed shop would cut these illustrations out of the catalogue and with the aid of the building plan he would be ready to proceed with his work without calling upon the drafting-room until the final record was to be made.

Toledo, Ohio. R. F. HILL

CHART FOR SAFE LOAD ON JOURNAL BEARINGS

The problem of determining proper bearing sizes to fit varying conditions of speed and load is one with which every designer should be familiar, yet very frequently we see attempts made to design bearings without due consideration of the factors which determine the work done in the bear-

ing. In overcoming the friction between a journal and its bearing, a certain amount of energy is expended which shows itself in the form of heat. The only means of getting rid of this heat is by conduction from the heat generating surfaces, through the masses of the shaft, bearing and bearing support, and thence by radiation to the outside air. Of course, the oil to a certain extent serves as a medium for the transfer of a part of the heat generated, by giving up its heat to the walls of the oil chamber; but by far the greater part is dissipated by conduction in the manner described.



Curve giving Safe Load per Inch of Bearing Length

Inasmuch as there is always some heat generated in the bearing, no matter how liberally it may be designed, there must always be a temperature increase in the bearing. If this heat can be carried off as fast as it is generated, the bearing will at some time in its operation reach a constant temperature. As the radiating capacity of any bearing is a fixed quantity, the temperature reached will depend on the rate at which heat is generated; therefore, in order that a bearing may not overheat, there must be some means of determining this rate, and fixing a limit to which the amount of heat generated may be carried. Between bearing surfaces, as in all cases where relative motion takes place between two surfaces in contact, the work done in overcoming friction depends on the rate of motion and the pressure existing between the two surfaces. This is modified to a certain extent by the character of the surfaces in contact, but for practical purposes, it is sufficient to consider the two factors of speed and pressure, and as the work done is proportional to each it is proportional to their product. By fixing the product of these factors as a constant, we have a means of limiting the work done in the bearing to a safe quantity.

It has been found by observation of a large number of bearings that were known to operate within a temperature rise of 40 degrees C. that if the rotative speed is taken in feet per minute, and the pressure in pounds per square inch of projected bearing area, the constant lies between the limits of 36,000 and 40,000. If we use the smaller number, and let

d = diameter of bearing in inches,
l = length of bearing in inches,
L = total load on bearing in pounds,
$\frac{L}{l} = P$ = load on bearing per inch of length,
N = revolutions per minute,

we have,

$$\frac{\pi dN}{12} \times \frac{L}{dl} = 36{,}000$$

which reduces to

$$\frac{NL}{l} = 137{,}000, \text{ or } NP = 137{,}000.$$

From this we see that if the product of the revolutions per minute and the load on the bearing per inch of length does not exceed 137,000, the bearing will operate within the temperature rise specified. By plotting these factors, the accompanying curve was obtained, which presents this formula in a convenient shape for use. By reading across to the curve from revolutions per minute at the left, and thence down, the safe load per inch of bearing length will be found.

In determining the pressure on the bearing, any load due to belt or chain pull, or gear thrust, in addition to the direct weight of the shaft and member carried by it, must be taken into account. In the majority of cases the belt pull will be at an angle to the direct weight on the bearing; the gear thrust may be in any direction—most frequently, however, in the same direction or opposite to the direct weight. In any case, a resultant of the forces operating on the bearing must be taken and used as the final load figure.

It will be noted that the diameter of the bearing does not have to be considered in determining its safe load. While it enters into the formula as a factor of the rotative speed, it also has the function of directly reducing the pressure per square inch of bearing area, so that it is eliminated from the formula in its final shape. The diameter of the bearing is generally fixed from other considerations, being chiefly dependent upon the size of shaft required for stiffness, and for transmitting the given horsepower.

Westfield, N. J. ALAN M. BENNETT

CHECKING LIST FOR AUTOMOBILE TOOL DRAWINGS

The following is a checking list used with success in checking the automobile tool drawings of a large eastern automobile factory. If followed with care when checking, there are not many mistakes likely to get by the checker. It is advisable to have such a list, for as was the case with the company in mind, we had no regular checker but each tool designer checked his fellow tool designer's work. The list follows:

1. Is the size of sheet correct?
2. Is the layout of the model correct?
3. Can fixture be loaded and unloaded without interference?
4. Can the fixture be assembled?
5. Do figures "tie up"?
6. Are there enough dimensions on each piece?
7. Do the dimensions scale?
8. Are dimensions not to scale underlined?
9. Are finish marks on drawing?
10. Have "grind" notes and other necessary notes been included?
11. Does the fixture fit the machine and have bolt holes been provided?
12. Is the stock list and bill of material on the drawing?
13. Spot for marking?
14. Have title and piece number, pattern number, order number and sheet number been given?
15. Has provision been made for gaging on milling fixtures?
16. Is the pattern constructed in the simplest manner within reason?
17. If a chucking fixture, is it counterweighted?

Hartford, Conn. S. VICTOR BROOK

* * *

RECORD FOR HAULING LONG TRAINS

All previous records for hauling long trains were lately broken by the Erie R. R. Mallet "triplex" locomotive recently built by the Baldwin Locomotive Works. The train consisted of 250 fifty-ton steel gondola loaded cars and a dynamometer car, the total weight of the train being 35,824,000 pounds, or 17,913 tons exclusive of the locomotive. The total length of the train was 8547 feet or 1.6 mile. The train was hauled by the locomotive twenty-three miles between Binghamton, N. Y., and Susquehanna, Pa. It was assisted in starting by pushers, but after the cars were under way, no further assistance was given. The locomotive weighs 853,000 pounds, and has a tractive power of 160,000 pounds. It has twelve driving wheels on each side, arranged in three groups of four wheels each. A pony truck in front and at the rear makes the total number of wheels supporting the unit twenty-eight. The design, originated by G. R. Henderson, consulting engineer of the Baldwin Locomotive Works, makes 89 per cent of the total weight of the engine and tender available for tractive effort.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

HARDINGE PRECISION LATHE WITH QUICK CHANGE OF SWING

To meet the requirements of tool-rooms, instrument factories and scientific shops where precision lathes are needed, Hardinge Bros., Inc., Berteau and Ravenswood Aves., Chicago, Ill., have added to their line the "Cataract" precision lathe with quick change of swing, which is illustrated herewith. The nominal swing of this machine is 9 inches, but raising blocks are provided which may be placed under the headstock, cross-slide and tailstock to increase the swing to 15 inches. Fig. 1 shows the machine arranged to swing 9 inches, while in Fig. 2 the raising blocks are shown in place to increase the swing to 15 inches. With the exception of the gear on the spindle, the entire change gear mechanism is carried by a frame attached to the end of the bed, and this construction makes it possible to effect the change in swing without interfering with the change gears.

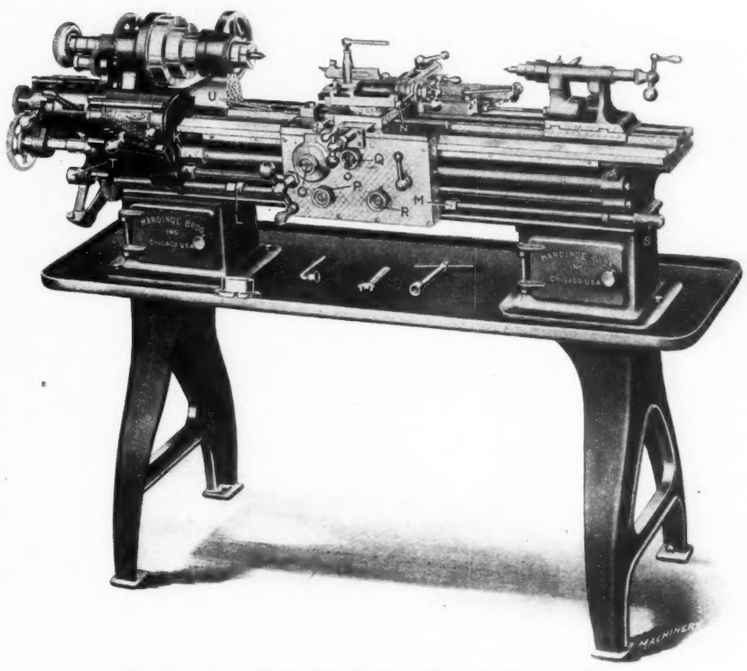


Fig. 1. "Cataract" Precision Lathe with Quick Change of Swing

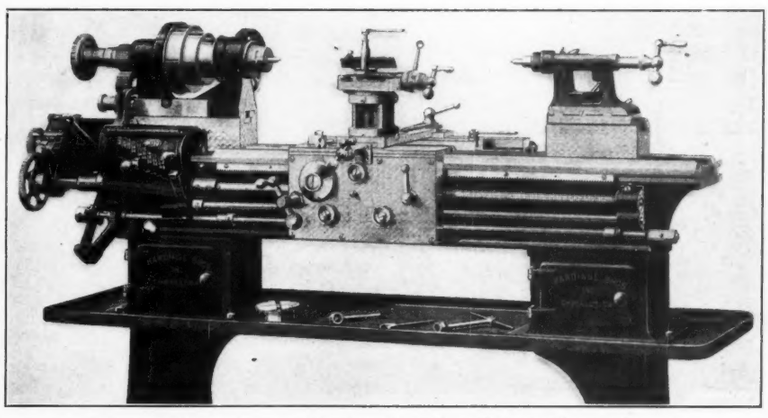


Fig. 2. Machine shown in Fig. 1, with Raising Blocks in Place to increase Swing to 15 Inches

Fig. 3 shows the headstock removed from the machine, and two brackets *A* and *B* which carry the auxiliary change gear mechanism are also shown in this illustration. In Figs. 4 and 5 two views of the head are shown with the brackets *A* and *B* mounted in place. It will be seen that two equal gears are carried by the bracket *B*, and these gears are employed to make the connection between the spindle gear and the gear on the stud *F* when the swing of the lathe has been increased to 15 inches. The gears on bracket *B* are merely idlers and do not affect the ratio of the gearing in any way. The gears carried on bracket *A* provide for making a reduction in the rate of feed. In order to use these gears the pinion carried on stud *F* is thrown out of mesh and the gear carried in the sector *C* is brought into mesh with the gears on the bracket *A*, which are now employed to transmit the motion from the spindle gear to the quick-change gears. The illustration shows the bracket *A* provided with gears which give a reduction of 1 to 2½, and by employing suitable gears any required reduction may be obtained.

The quick-change gear-box contains a nest of nine gears and the changes of feed are obtained by bringing the lever *G* into the correct position. Referring to Fig. 4 it will be seen that the different numbers of threads per inch obtained in each position are marked on the front of the box, the lever *G* being shown in the "lock-out" position. It will be seen that there are three numbers marked at each station in the quick-change gear-box, and with the lever *G* set at any given station the three numbers of threads per inch are obtained by means of gears which are engaged by manipulating the lever *H*. For instance, suppose it is required to cut a screw with 48 threads per inch. The lever *G* is set under 48 and the lever *H* is set in the "slow" position. At the same station on the quick-change gear-box where 48 appears, the numbers 24 and 12 are also marked. To engage the proper gearing for cutting screws with these numbers of threads per inch, the lever *H* is set in the "medium" and "fast" positions, respectively.

Any English threads which are not obtainable through the quick-change gears can be obtained by mounting the proper gears on the screw *I* and stud *J* and connecting them through the gear on the sector *D*, compounding the gearing at *D* when necessary. For instance, with a 20-tooth gear on stud *J* and a 100-tooth gear on screw *I*, provision is made for cutting a 100-pitch screw. Such being the case, it will be evident that to cut a 50-pitch screw it would merely be necessary to use a 40-tooth gear on the stud *J* instead of the 20-tooth gear formerly employed; or to put a 50-tooth gear on the screw *I* and leave the 20-tooth gear on the stud *J*. Suitable translating gears are provided for cutting screws with metric pitches.

In connection with the preceding description of the facilities for precision thread cutting, attention should be called to the connection *K* on the lead-screw. This connection provides for disconnecting the lead-screw in such a way that only a few minutes is required to remove the screw and replace it by one of another pitch. This is particularly convenient in instrument work where screws of special pitches are required, and in cases where it is occasionally necessary to employ a standard lead-screw which it is not desired to have in use on the machine any more than is absolutely necessary. The nut used on the lead-

screw is 3½ inches in length so that ample wearing surface is provided.

The travel of the carriage is controlled by adjusting stops *T* and *S*, and stop collars *L* and *M*. The design is such that it is impossible to engage the lead-screw and feed-rod simultaneously. Referring to Fig. 1, the handle *P* is for the power feed and handle *Q* for the cross feed. The handle *R* controls the lock-out which makes it impossible to engage the feed-screw and lead-rod at the same time. The graduated disk *O* is arranged with a vernier so that accurate settings for the

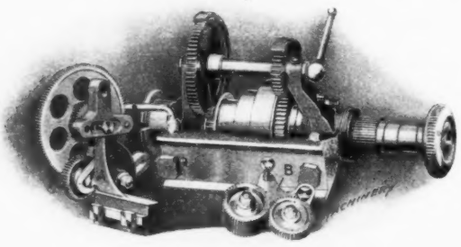


Fig. 3. Head and Auxiliary Gear Brackets A and B

depth of cut can be made. The compound rest is equipped with a quick-acting nut which is operated by turning the handle *N* through one-half revolution to a stop. In this way the tool may be advanced or withdrawn up to 5/32 inch. This does not interfere with the regular use of the compound slide and will be found particularly convenient in threading taps and similar classes of repetition work. It relieves the operator of the necessity of continually watching the indexes and does away with spoiled work resulting from mistakes which even the most conscientious operator is likely to make occasionally.

The taper turning attachment is attached to the carriage and graduated to provide for cutting tapers expressed in degrees or inches per foot. The design of this attachment is such that it may be readily withdrawn to provide for running out the cross-slide quickly to insert the bolt for the raising block which goes under the compound rest when it is required to increase the swing of the machine to 15 inches. The taper attachment can be used on work up to 15 inches in length and is adjusted for various tapers by means of a fine pitch screw. The backing-off attachment is driven by a worm-gear carried on the spindle nose and is attached to a T-slot machined in the back of the bed. This attachment operates the cross-slide through a cam of suitable form.

Structural Features of the Machine

A general description has now been given of those mechanical features of the machine which make it particularly

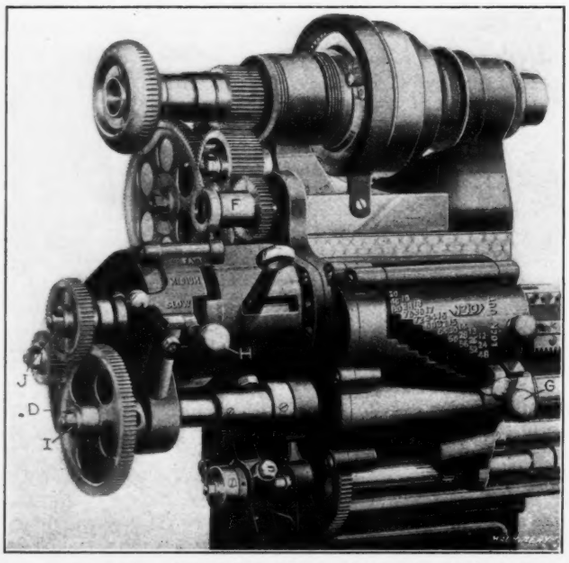


Fig. 4. Front View of Head End of Lathe with Raising Blocks in Place

adapted for the most exacting requirements of precision work. By way of conclusion a brief description of the structural features will doubtless prove of interest. The head is 11½ inches long and is provided with adjustable bearings. These bearings are made of fine cast iron and the spindle is of hardened steel ground to an accurate finish. The bearings are lubricated by means of wicks which dip into an oil reservoir in the head of the machine. All dirt or dust is excluded from this reservoir and the wicks act as filters which effectually prevent any foreign matter from reaching the bearings. The spindle nose is made of the Hardinge patented form which provides for the quick attachment of faceplates, etc. The bed is machined to the same standard as the "Cataract" bench lathes manufactured by Hardinge Bros., so that turrets, milling attachments, etc., may be interchanged between different machines.

The principal dimensions of the machine are as follows: Length of bed, 52 inches; total length of lathe, 64 inches; maximum distance between centers, 28 inches; swing over bed, 9 inches and 15 inches; swing over carriage, 6½ and 11½ inches; size of front spindle bearing, 2 inches long by 2 1/32 inches in diameter; size of rear spindle bearing, 2 inches long

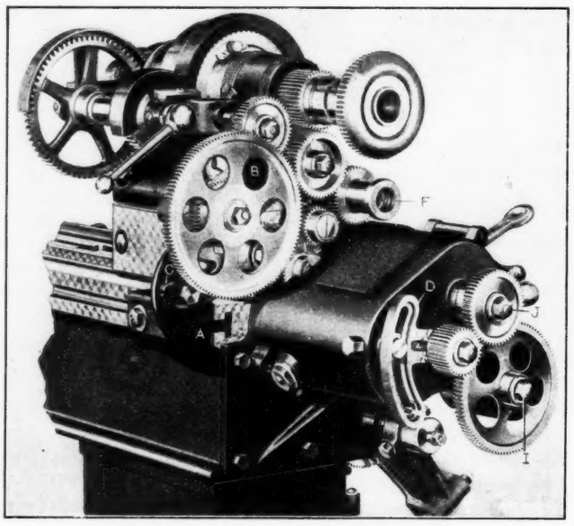


Fig. 5. Rear View of Head End of Lathe

by 1⅞ inch in diameter; diameter of hole through the spindle, 1¼ inch; capacity of the draw-in chuck, 1 inch; floor space occupied, 24 by 64 inches; and net weight of machine, 900 pounds.

B. & S. MILLING ATTACHMENT FOR CUTTING SHORT LEAD SPIRALS

The piece of work shown in position is a steel drum 6 inches in diameter on which a single thread of 1/18 inch pitch is required. The thread is rounded at the bottom and must be accurate in form and lead. The method usually employed in milling such leads is to connect the table feed-screw directly to the spiral head spindle by gearing in the proper ratio, so that the work is rotated from the screw. This, however, necessitates gearing up from the screw to the work in a considerable ratio, putting a load on the screw which results in uneven turning action and a poor thread. Accordingly, the attachment which is illustrated herewith was devised to overcome this difficulty.

The two most notable features are the method of applying power for driving the work, and the system of gearing employed to obtain the lead of the spiral. A small grooved pulley mounted on an expansion bushing is placed on the rear end of the machine spindle. This drives the large grooved pulley by a round belt. By mounting this pulley on a bracket slipped on the overhanging arm, sufficient adjustment is provided for keeping the belt tight or for using the same belt crossed or open. The remainder of the attachment consists of a bracket carrying a short shaft and a swinging arm, the shaft being driven from the grooved

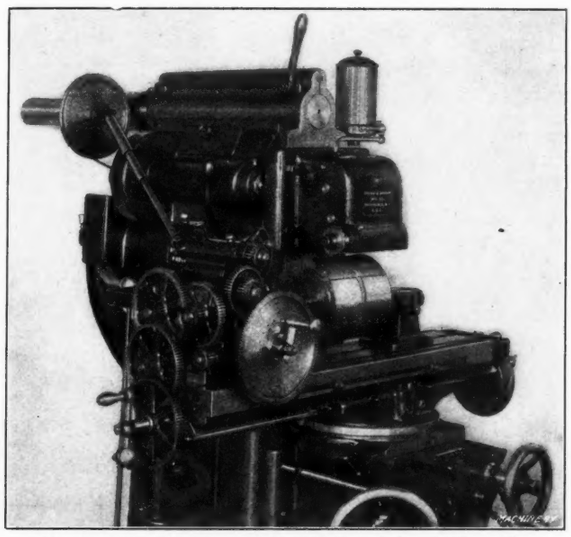


Fig. 1. Brown & Sharpe Milling Attachment for Use in cutting Spirals of Short Lead

pulley by a telescopic shaft and universal joints. The bracket is clamped over the dovetail on the top of the regular spiral head.

In place of the usual index plate a large gear is employed, through which the power is transmitted from the grooved pulley to the spiral head spindle, thus rotating the work. The movement of the work may be instantly stopped by means of the small lever on top of the bracket which operates a positive clutch. Eighteen holes are provided in the large gear to be used when cutting double, triple or other multiple threads. This independent driving mechanism does away with all driving stress on the table feed-screw. The regular feed mechanism is thrown out of engagement and the screw is only used to obtain the lead. This is accomplished by connecting the worm shaft of the spiral head to the table screw through triple compound gearing the ratio of which is 180 to 1. Power is therefore transmitted from the spiral head to the screw in a very high, descending ratio. The turning action of the screw is thus easy and smooth, resulting in threads of greater accuracy in lead and form than those obtained previously.

This attachment was designed by the Brown & Sharpe Mfg. Co., Providence, R. I., and it is arranged to be quickly placed on any regular Brown & Sharpe milling machine which carries a 10-inch spiral head. No fitting or drilling of holes is necessary, and very few extra gears are required in the triple compounding beyond those furnished regularly with the spiral head. A reverse gear and plate may be used in addition to those shown when cutting a thread of the opposite hand. Fig. 2 shows the attachment rigged for the same conditions but with a different system of gearing employed. Here the spiral head spindle is connected directly to the table feed-screw to give the same lead as before. The train of gearing is much simpler than in the previous case as the ratio is only 4.50 to 1. However, this method can only be used to advantage on single threads, as it does not permit of indexing, while the thread produced in many cases is not as accurate as when using the high ratio gearing. The cutter may be mounted on a regular rack-cutting attachment or a vertical spindle milling attachment when used on a universal milling machine. The latter attachment can only be used in the case of a large cutter, while the former permits the use of a small cutter. By using a universal milling attachment in this connection, the work may be done on a plain milling machine, the attachment having means for setting for the required angle of spiral.

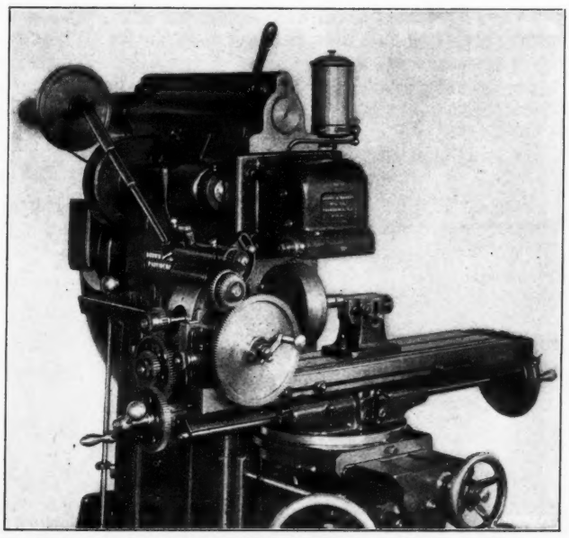
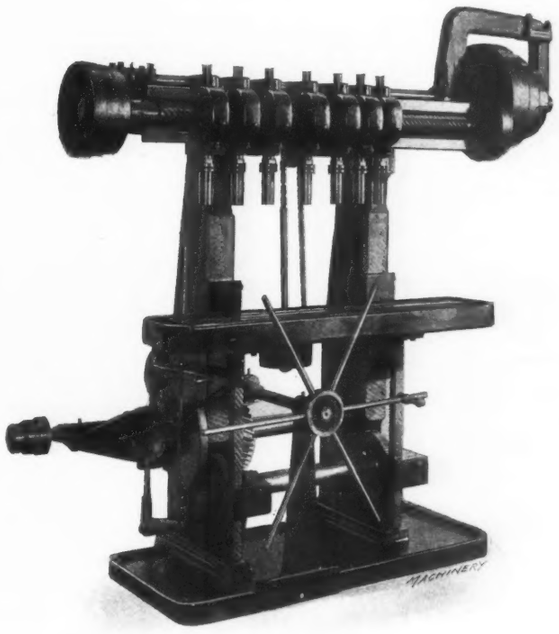


Fig. 2. Same Attachment shown in Fig. 1 but arranged with a Different System of Gearing

MOLINE DRILLING MACHINE

The latest addition to the line of "hole hog" machines built by the Moline Tool Co., Moline, Ill., is the No. 54 drill illustrated and described herewith. The characteristic feature of the design is that both cam and geared feeds are provided. For any special work that has to be handled in large quantities, a feed cam is made which is formed in such a way that the drill is quickly fed through any gaps that may exist in the work and also returned quickly to the starting point after the hole has been finished. The machine may be operated continuously or made to stop automatically at the loading point, as desired. The feed cams are easily changed so that it is entirely practicable to have a number of cams for handling different classes of work on the same machine. The cams are inexpensive, and as they materially increase the rate of production they should be used in machining all work which has to be handled in quantities. When small pieces are to be drilled, a sliding jig provided with alternate working and loading stations makes the use of stops unnecessary, the drill being operated continuously. For general work, the geared feed is used in connection with the automatic stop and quick hand return. This makes a valuable combination, as it combines the advantages of a special and general purpose machine.



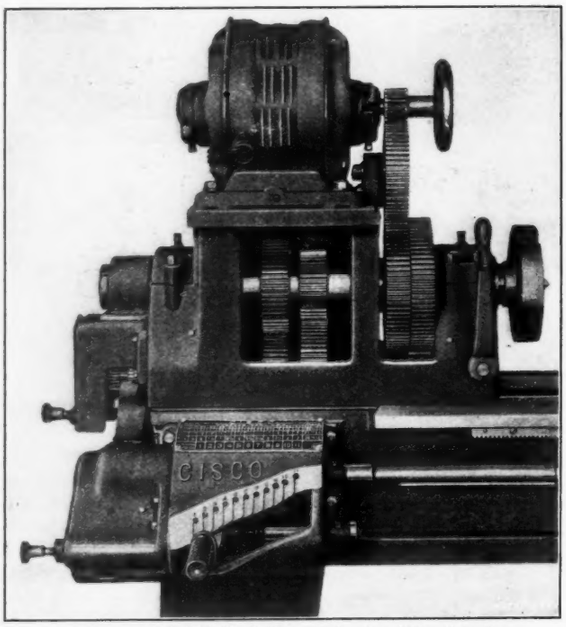
Moline No. 54 Drill equipped with both Cam and Geared Feeds

The No. 54 Moline drill has one main spiral gear, as shown in the illustration; but if so desired, it can be equipped with two main spiral gears, this design permitting holes to be

drilled on closer centers. The machine equipped with the two gears is known as the No. 54-D machine. These machines are made in seven different lengths ranging from 4 to 10 feet, and are adapted for handling a great variety of bars, pipes, drop-forgings and castings. The machines 8 feet or more in length are built with three columns. The No. 54 machine is intended to take the place of the No. 8 cam-feed machine formerly built by this company. In addition to performing all operations which could be handled by the No. 8 machine, it has the advantages of being able to change the cams quickly, of only requiring one cam to be used instead of two, as on the No. 8 machine, and of being equipped with geared feed to adapt the machine for handling general classes of work.

MOTOR DRIVE FOR "CISCO" LATHE

The accompanying illustration shows the arrangement of motor drive which has recently been developed by the Cincinnati Iron & Steel Co., Cincinnati, Ohio, for use on the lathes of its manufacture. A 2½ or 3 horsepower, direct or alternating current motor of variable or constant speed, is employed. Three changes of speed are provided in the head, two of which are controlled by a lever at the front of the head which operates the friction, while the third is an open speed obtained through the face gear. In order to use the open speed, it is necessary to have the lever on the front of the



Arrangement of Individual Motor Drive for "Cisco" Lathes

head set in the neutral position. The illustration shows a new arrangement of the change gear box in which guides are provided for the tumbler so that the operator can easily obtain the various changes.

The Cincinnati Iron & Steel Co. is sending 14, 16 and 18 inch lathes of its manufacture to San Francisco where they will be shown at the Panama-Pacific Exposition. One or two minor improvements have been made in the design of these lathes. A pull pin is provided at the end of the lathe and when this pin is in the neutral position, the lathe can be run at high speed with all of the gears from the first compound out. The design of the half-nut is such that it is impossible for the lead-screw to be clamped too tightly. The beds of these new "Cisco" lathes are made deeper and heavier and they are of "semi-steel" which affords unusual strength and permanence of alignment. This design and material will be used by this company from now on. Various other minor improvements have been made in the design of the machines.

WATSON-STILLMAN JACK

The Watson-Stillman Co., 192 Fulton St., New York City, has recently added to its line a hydraulic jack which embodies several important features in its construction. It is primarily intended for use as an emergency jack for street railway service, but is also suitable for use in many shops and factories where it is necessary to lift heavy work.

Watson-Stillman Emergency Jack

The following are the important features of the design: The claw can be moved vertically and adjusted to the most convenient height; and the claw and cylinder can be swung in a complete circle without changing the position of the jack. The cylinder is the moving part instead of the ram as in most types of hydraulic jacks, thus allowing the pump mechanism to stay in a fixed vertical position and permitting the working parts of the jack to be of simple and compact design. The piston is packed with leather rings, the valves are of the ball type and the passages are made of ample size. This jack is operated with a special oil which acts as a lubricant, prevents the working parts from rusting, cannot freeze and has no detrimental effect upon the packing. The pressure is released by means of a key which operates a small needle valve. Although the operating lever is only 18 inches in length, a man can obtain the maximum pressure without undue exertion. These jacks are built in 5 to 10 ton sizes with a ram stroke of 10 inches.

SLOCOMB DIRECT-READING MICROMETER

One of the latest products of the J. T. Slocomb Co., Providence, R. I., is a direct-reading micrometer for measuring the size of wire. This tool is provided with a direct-reading dial on which the size of the wire is given in steel wire gage, the decimal equivalent of an inch, and iron wire gage. It will be evident from Fig. 1 that the micrometer is easily held and operated with one hand, leaving the other free to handle the work to be measured. These features enable measurements to be made very rapidly.

The quick action of the micrometer is made possible by the provision of a coarse multiple-pitch screw that has a lead of ¼ inch. All measurements up to No. 80 steel wire gage, 0.25 inch and No. 36 iron wire gage may be read at one

Fig. 1. Method of using Slocomb Direct-reading Micrometer

Fig. 2. Dial of Slocomb Direct-reading Micrometer

revolution of the screw. It will be seen from Fig. 2 that the steel wire gage is graduated at the outside of the dial, the iron wire gage at the inside, and the scale giving the equivalent size in decimals of an inch is located between the two wire gage scales. The graduation of the dial emphasizes the non-uniformity of the common wire gages. Evidently it was intended to have the gages uniform at the time they were developed, but there was no good means of making accurate measurements at that time.

A micrometer of similar design has been developed for use in measuring card clothing. The nice degree of accuracy necessary in the manufacture of this material is not generally known, the average machinist having little knowledge of it except for use in making file cards or file brushes. That the degree of accuracy attained in its manufacture requires the use of a special micrometer will doubtless come as a surprise to many readers of MACHINERY.

WATERBURY-FARREL THREAD ROLLING MACHINES

The machine illustrated in Fig. 1 is one of a series of special reciprocating thread rolling machines equipped with magazine feed, which has been added to the line of the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. These machines are used for rolling threads of greater length than can be handled on the standard thread rolling machines built by this company. In working out the design, special attention has been paid to the maintenance of absolute rigidity in the frame and this feature has been further provided for by employing tie-rods at the part of the frame where the strain is greatest. These tie-rods prevent the frame from springing when threads of considerable length are being rolled and thus insure obtaining accuracy in the entire length of the thread.

Machines of this type are built for both hand feed and automatic magazine feed for headless blanks. In hand feeding the machine, the work is placed in front of a starting slide resting on an adjustable depth gage which is set to give the length of thread that is required. At the proper time, the blanks are pushed forward and gripped by the moving dies which roll the thread. The magazine feed is built for handling headless blanks that require threading on either one end or both ends, or for the entire length. This type of feed is adapted for threading pieces of the form used in harvester machinery, electrical machinery and special bolts, screws, etc., for a great variety of products which may require one end to have a right-hand thread and the other a left-hand thread. Of course, when threads are to be rolled simultaneously at each end of the blank, the diameter and pitch of the screws at both ends must be the same. Where the threads are rolled simultaneously on both ends of the work with a blank portion left between the threaded portions, the dies are separated by a filler of the same length as the portion of the blank which has to be left without a thread. Dies can be used for rolling either right- or left-hand threads as required.

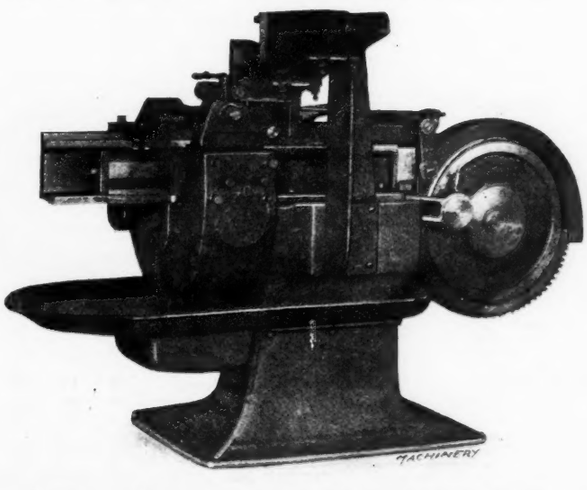


Fig. 1. Waterbury-Farrel Reciprocating Thread Rolling Machine

Fig. 2 shows examples of threads rolled on this machine. A screw with the gimlet type of point is shown at *A;* a machine screw thread rolled on one end of the blank is shown at *B;* a right-hand machine screw thread rolled at one end of the blank and a left-hand thread of the same type at the opposite end of the blank is illustrated at *C;* and at *D* a machine screw thread has been rolled the entire length of the blank. The machines are built with a pump, tank and lubricating system for keeping the dies flooded with lubricant while the threads are being rolled. They are built in several sizes with capacities up to and including screws 1 inch in diameter.

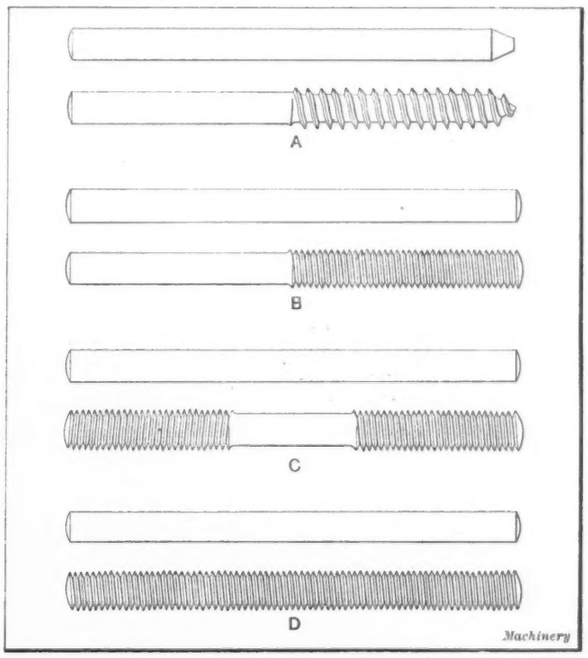


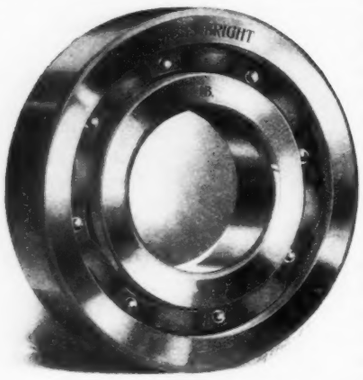
Fig. 2. Examples of Threads rolled on Machine shown in Fig. 1

HESS-BRIGHT "MONARCH" BALL BEARING

For use in the most severe classes of service where the requirements are so exacting that even ordinary ball bearings are unable to give satisfactory results, the Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa., has added to its line the "Monarch" ball bearing which is illustrated herewith. The races of this bearing are made heavier than those of standard annular bearings, to serve the double purpose of enabling the race grooves to be cut deeper and to provide more metal which will prevent the races from being sprung out of shape during the hardening and grinding operations or when placed in service. The ball cages are of cast bronze and made in two halves, which are riveted together. The design and construction of this bearing makes it more expensive than other types, but for the classes of service for which it is intended, the additional first cost is soon made up in a reduction of maintenance charges.

The general statement has been made that the races of this bearing are made exceptionally heavy to minimize distortion in the hardening and grinding operations, and when the bearing is placed in service. It may be mentioned in this connection that a special form of chuck has been

designed for use in machining the races, which supports the work all around its circumference instead of concentrating the pressure at three points. This prevents straining the race and the production of consequent inaccuracies in machining. Those who are at all familiar with the application of ball bearings know that for carrying an ordinary radial load, the outer race is made a "sucking" fit in the bearing housing. The idea is to have the race free to slide in the bore of the housing but still to have it uniformly supported. Slight inaccuracies in machining the housing may cause the race to be unequally supported, in which case there is the ever-present possibility of springing the race. The exceptional thickness of the races of the Hess-Bright "Monarch" type of bearing reduces to a minimum the possibility of trouble arising from this source. Similarly, the inner race is customarily made a pressed fit on the shaft and any inaccuracy of the shaft may result in springing the race out of its true circular form. Here, again, the exceptional thickness of the race reduces the possibility of this kind of trouble. The greater thickness of the races gives the bearing an exceptionally high capacity for carrying thrust loads.



Hess-Bright "Monarch" Ball Bearing

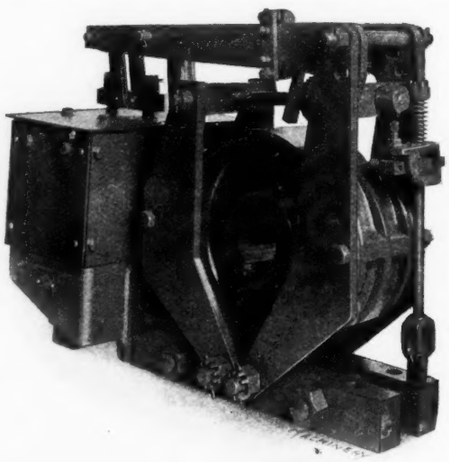
It has been stated that the ball cages are made of cast bronze. After these cages have been cast they are taken to a die where they are trimmed on the inside and outside to the required diameters. The cages are then taken to a hydraulic press where the inner surfaces of the ball pockets are subjected to high pressure in order to smooth the surface of the metal and bring each pocket to the required form. This method of finishing the ball pockets has been found superior to machining, and the small pits in the surface of the metal left from the molds act as oil retainers which are found to give good satisfaction in keeping the balls properly lubricated. One typical class of service for which the Hess-Bright "Monarch" bearing has been found particularly suitable, is on the armature shafts of the axle generators used in railway car lighting systems. The service conditions under which the bearings of these equipments operate are very severe, and wear in the bearings might result in bringing the armature into contact with the pole pieces of the generator, thus causing it to be put out of commission. That the new Hess-Bright bearings are well suited for the requirements of this service is evidenced by the fact that not a single case has been reported in which failure of the lighting system could be attributed to the bearings of the generating set on which they were used.

G. E. AUTOMATIC SOLENOID BRAKE

A new automatic solenoid brake for crane, hoist, lift bridge and similar service has recently been developed and placed on the market by the General Electric Co., Schenectady, N. Y. Exceptionally sturdy construction has been made inherent in the design on account of the severe character of the work demanded of the brake, and it is built in a complete line of standard sizes for both alternating and direct current application. All the sizes are so designed that they may be mounted on the floor even though ordered and shipped attached to the motor. In the larger sizes mounted on the motor—50 horsepower and over—the two base bars that support the brake are bolted to brackets, the latter being bolted to bosses cast on the motor frame. The two plate yokes that support each shoe are hinged at the lower end to the base bars, and act as levers for applying the necessary pressure to the shoes to make the braking effective. The force that operates the brake is transmitted to the free or top ends of the yokes through horizontal levers, which are attached to the movable element of the solenoid by means of links. When the solenoid is energized, the movable element is forced up to the end of its travel, releasing the brake; and when the coil is demagnetized, the brake is set by gravity. In the sizes below 50 horsepower, the brake has a box type of frame, which is attached to bosses on the motor frame. Cast yokes are employed in this type, but in other respects the brake is similar to that for motors with capacities of 50 horsepower and above. All these designs may be modified to suit the requirements of such special applications as lift bridges, printing presses, etc.

The brake has three unique features: an automatic solenoid air-gap adjuster, an automatic shoe clearance adjuster, and a floating top core type of solenoid. The solenoid air-gap adjuster is designed to maintain constant the distance between the upper, or floating, and the lower cores of the solenoid when the brake is on. The solenoid air-gap adjustment is made by means of a ratchet wheel, pawl and adjustment rod shown in the illustration, which represents the type of brake designed for motors of capacities of 50 horsepower and above. The pawl is so designed that when the air-gap in the solenoid, *i. e.*, the distance between the upper and lower cores, increases beyond a certain value, the pawl will engage with a tooth of the ratchet wheel and rotate it slightly when the movable element of the solenoid is forced up by the magnetic field of the latter to release the brake. This shortens the air-gap in the solenoid slightly, with the result that the movable element does not drop far enough when the brake is set for the pawl to engage the ratchet wheel again until the shoes wear sufficiently to permit it. One tooth on the ratchet wheel corresponds to a slight variation in the distance between the upper and lower solenoid cores, so the adjustment is very close.

In the shoe clearance adjuster, a rod attached to one of the base bars passes through a bracket bolted to one of the yokes. This bracket has a slot for a spring clamp attached to the rod. As the shoes wear, allowing the yokes to approach



General Electric Automatic Solenoid Brake for Crane, Hoist and Lift Bridge Service

slightly nearer to the wheel when the brake is set, the spring clamp is moved up correspondingly by the bracket, these two parts being in contact when the brake is on. As soon as the brake is released, the right-hand yokes move back under the influence of gravity and the spring until the set-screw strikes the spring clamp. Thus the distance between these two positions of the shoes, *i. e.*, the shoe clearance, is maintained constant. The braking effect may be increased by changing the lever pin to one of the other sets of holes designed for it, and also by removing one or more of the weights on the movable element of the solenoid. An oil dash-pot, single acting in the downward direction, is supplied with the larger sizes to prevent any rebound of the movable element of the solenoid at the instant of setting the brake, thus giving a smooth application. The dash-pot effect may be varied, but

all dash-pots are correctly adjusted at the factory, using an oil that is little affected by changes in temperature.

The solenoids supplied with these brakes are enclosed, ventilated, rain-proof and provided with a floating top core. When the movable element reaches the upper limit of its travel, it strikes the floating top core which is held in place by magnetism and yields slightly, preventing a severe blow being struck. Since, in ordinary service, solenoids operate several times per minute, it is readily seen that this is a great gain, as it materially adds to the life of the coil and other parts, and also insures smoother operation. With respect to direct current brakes, a series wound coil is standard for crane work. All standard series brakes release on 40 per cent of the rated full load current of the motor to adapt them to dynamic braking. There are special applications which require a shunt winding, as, for instance, bridges where the motor coasts with the current off and the brake released. Alternating current solenoids are shunt connected. Coils for such high potentials as 2200 volts can be furnished, if desired, for standard frequencies ranging from 25 to 60 cycles. These are single phase and therefore suitable for single, two and three phase circuits without change.

Brakes are rated in pounds retarding torque at one foot radius on the brake wheel shaft, the term "retarding torque" being applied to the torque when the armature of the motor is rotating. When the armature stops rotating, the "holding torque at rest" of the brake increases considerably. This is due to the fact that the coefficient of friction when the wheel is at rest is greater than when it is rotating. All brakes have a maximum retarding torque of not less than the full load torque of the motors on which they are used. The design of the solenoid coil, shoes, and other parts is such as to permit of ready removal. All wheels are cast steel, as this metal gives maximum strength with minimum weight. They are perfectly balanced, and those for the mill type of motors and alternating current crane and hoist motors are taper bored to facilitate removal of the wheel. All wheels are of small diameter so as to have a small flywheel effect, and of wide face to insure ample wearing surface. The brake is so designed that the wheel cannot drop off even though it may accidentally work loose. The solenoid coil is connected to the controller so that when the latter is thrown to the "on" position, the movable element of the solenoid is raised, thereby releasing the brake and allowing the motor armature to revolve freely. When the controller is thrown to the "off" position, or when the power fails, the movable element drops, thus causing the brake to set and hold the motor armature from turning. In special cases, as for instance, in the service on a lift bridge where the brake and motor turn through an angle, the brake is set by means of a spring, which insures constant braking effect at all angles.

HORTON COMBINATION GEARED SCROLL CHUCKS

A recent addition to the line of lathe chucks manufactured by the E. Horton & Son Co., Windsor Locks, Conn., is illustrated in Fig. 1; and Fig. 2 shows the parts of this chuck. This is known as a combination geared scroll chuck because all of the jaws may be operated in unison by means of the scroll gearing, while each jaw may be operated independently by means of a screw. It will be seen that the chucks are equipped with solid reversible jaws, and this style of chuck is made with either three or four jaws. In order to avoid the inconvenience arising from the possibility of having the screws drop out when the jaws are

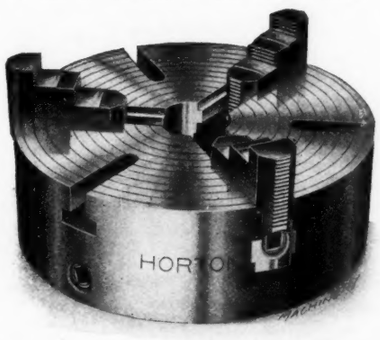


Fig. 1. Horton Combination Geared Scroll Chuck

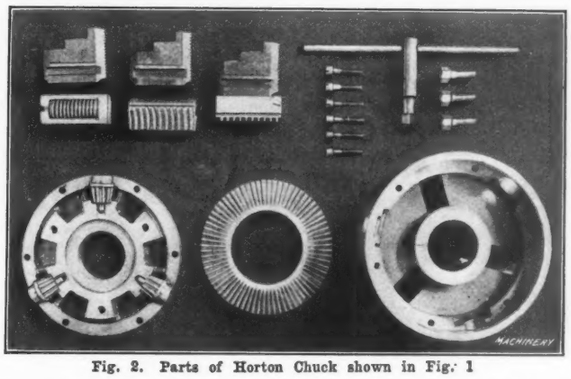


Fig. 2. Parts of Horton Chuck shown in Fig. 1

removed for the purpose of reversing them, a special form of screw carrier has been designed, this carrier being shown in detail in Fig. 3. The socket in which the screw is held is just a little more than semi-cylindrical so that the screw cannot drop out, and it will be seen that the plug *A* is threaded into the end of the carrier and locked in place by two binding screws. The independent screws are made in a screw machine, after which they are threaded, carbonized, heat-treated and ground from end to end. The screws are exceptionally large and are not necked down at the ends, so that maximum strength is obtained.

The standard jaws and screws of the form used in the new Horton independent chucks are employed in the combination geared scroll chuck. The size of the screws is such that in

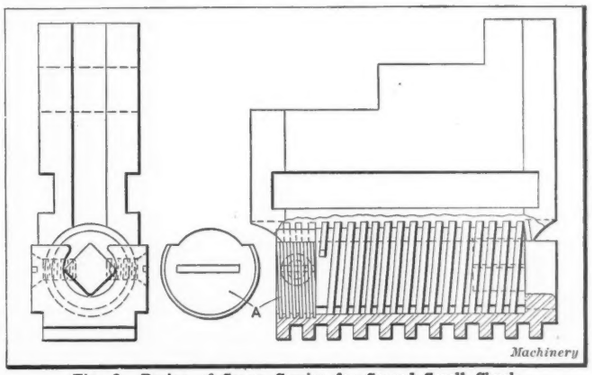


Fig. 3. Design of Screw Carrier for Geared Scroll Chuck

chucks of the 6-inch size and larger, only one wrench is required, which is used for operating both the scroll pinions and the screws which control the independent movement of the jaws. The pinion which operates the scroll gear has exceptionally strong teeth, and by referring to Fig. 2 it will be seen that a steel band encircles the hub of each pinion. This band is pressed onto the hub, and in addition to taking the end thrust of the pinion the band adds to its strength. It has already been mentioned that both three- and four-jawed chucks are now being manufactured, and both styles of chucks are made in sizes ranging from 4 to 24 inches in diameter.

Fig. 4 shows another new product of this company, which is known as style 50-C independent four-jawed chuck. It will be seen that this is of the reversible jaw type. Steel thrust blocks of rectangular section are provided in the body of the chuck. These are hardened and ground, and carry the thrust of the screws. The screws are of large diameter; they are self-contained within the chuck body and have large thrust

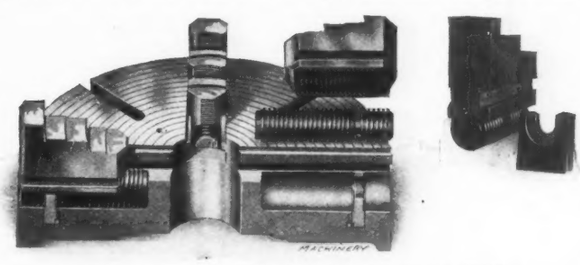


Fig. 4. Horton No. 50-C Independent Four-jawed Chuck

contact against these hardened thrust blocks. After being threaded the screws are heat-treated and ground. The illustration makes the design clear without requiring an extended description.

BRISTOL LONG DISTANCE INDICATING AND RECORDING SYSTEM

A new electrical long distance transmitting, indicating and recording system has been placed on the market by the Bristol Co., Waterbury, Conn. In this instrument, Bard's patented long distance induction balance movement is employed; and Bristol recording instruments, when equipped with this electrical transmitting system, are capable of producing automatic and continuous records of pressure, liquid levels, temperatures, mechanical motions, etc., even at distances of many miles from points at which the transmitters are located. Fig. 1 shows a standard unit of this transmitting and recording instrument, including the transmitting indicator

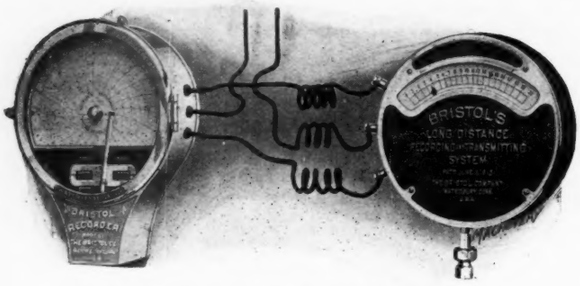


Fig. 1. Arrangement of the Standard Transmitting and Recording Instruments

for installation at the point where the pressure or temperature, etc., is measured, and the receiving recorder which is installed at the remote point where it is desired to have the record produced. The two instruments are shown connected by three wires, one of which is connected to a source of alternating current, as for instance, a lighting circuit. This long distance system is particularly well adapted for use under ordinary operating conditions because of its simplicity of construction. There are no sliding or make-and-break contacts employed, and the effects of variation of temperature or resistance along the circuit are negligible. The recording instrument may be installed many miles distant from the measuring and transmitting device. For instance, if 110 volts and No. 14 copper wires are used, the recorder may be located thirty miles from the transmitter, or if No. 12 leads are used the recorder can be installed forty miles or more from the transmitter. The transmitting device is mounted in a moisture proof case, and can be installed outdoors if necessary.

The fundamental principle of the Bristol long distance transmitting and recording system is that of the induction balance. The transmitting instrument and the receiving instrument are each equipped with two pairs of coils arranged to swing in a horizontal plane over iron cores. Fig. 3 shows the interior of one of the transmitting instruments. In this instrument the helical form pressure tube and the electrical transmitting device are shown in the operating position. The complete outfit consists of two pairs of mechanically balanced solenoids arranged to swing horizontally back and forth over the ends of soft iron cores and connected in parallel to an alternating current circuit. One pair of the solenoids is used for the transmitting instrument, the other pair for the receiving instrument. The front view (Fig. 2) of the transmitter shows one pair of the solenoids *A* and *B* on spools that are connected and supported on a shaft, the ends of which rest in jewel bearings at *G* and *F*, and which is free to swing back and forth over laminated soft iron cores *C* and *D*. The top view (Fig. 4) shows the solenoids *A* and *B* of the transmitter in section, and by the dotted outline the position to which the solenoids may swing is also indicated. A similar pair of balanced solenoids is placed in the receiving recorder or indicator at the distant point. When the solenoids *A* and *B* of the transmitter and receiver are connected in parallel to an alternating current circuit, and the transmitter coils *A* and *B* are held in a certain position by the operating mechanism located at *E* (water level gage, pressure gage, thermometer, etc.) the relative amounts of current flowing in solenoids *A* and *B* will depend on their positions on the iron cores *C* and *D* due to the inductive effect exerted in this way.

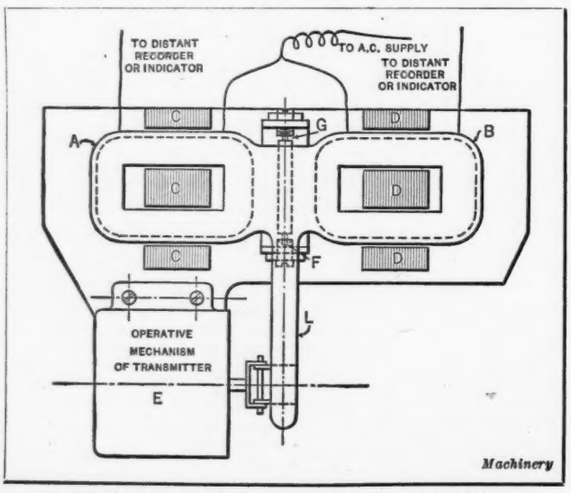


Fig. 2. Diagram showing Arrangement of Transmitter Solenoids

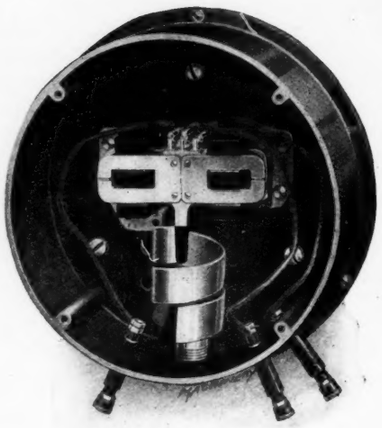


Fig. 3. Interior of the Transmitting Instrument

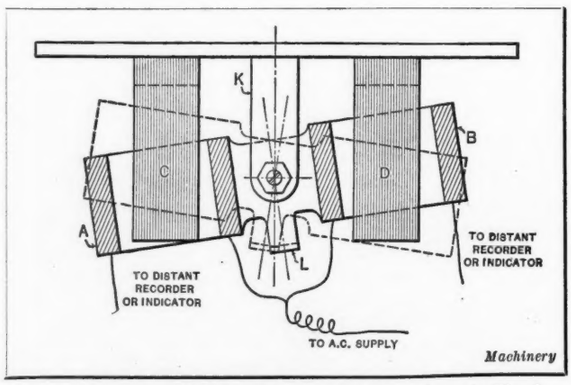


Fig. 4. Diagrammatical Top View of Mechanism shown in Fig. 2

At the receiving instrument the other pair of solenoids are mechanically balanced and free to take an angular position which will be the same as that of the transmitter, since the flow of current will be the same in the corresponding solenoids of the receiver as in the transmitter. If the angular position of the pair of solenoids at the transmitter is changed by the operating mechanism, thus moving one of the solenoids off and the other on to the iron cores—increasing the inductance in one solenoid and diminishing it in the other—the flow of current will be proportionately increased in one coil and diminished in the other. The variations of current at the distant receiver will correspond with the variations at the transmitter, and cause the pair of solenoids of the receiver to seek a position of balance which will be the same as that of the solenoids of the transmitter. In the transmitter the operating mechanism is linked directly to the balanced solenoids by means of an arm *L*. In the receiver the recording pen or the indicating pointer is connected to a similar

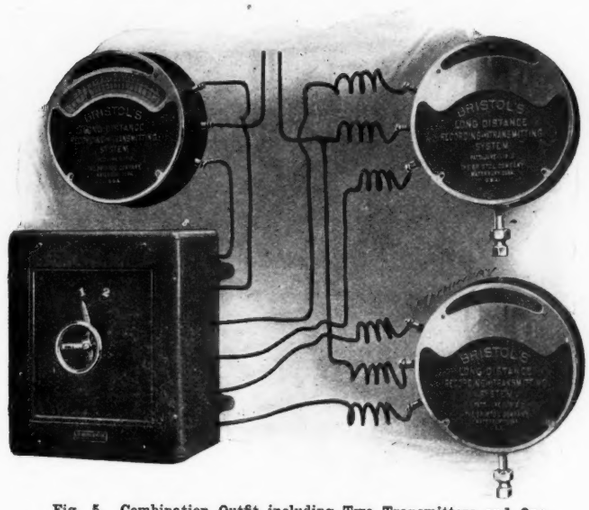


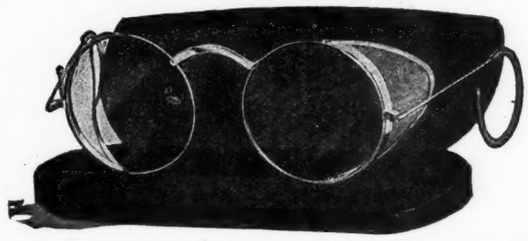
Fig. 5. Combination Outfit including Two Transmitters and One Receiving Indicator, connected to Two-point Rotary Switch

arm through a simple and practically frictionless multiplying mechanism.

Various combinations of transmitting and receiving instruments, of either the indicating or continuous recording type, may be furnished. Fig. 1 illustrates the standard equipment including a transmitting indicator and a receiving recorder, but it is possible to furnish the transmitter and receiver in either the indicating or recording type. Fig. 5 shows a combination outfit including two transmitters and one receiving indicator connected with a two point rotary switch so that readings may be obtained with the indicator of the pressures, temperatures, etc., from either of the transmitters. A great variety of applications for this apparatus will probably arise, owing to its flexibility and extreme simplicity.

WILLSON SAFETY GOGGLES

About a year ago announcement was made of the Willson safety glasses which were developed to protect the eyes of men engaged in chipping castings and in other classes of work where the eyes were likely to be injured through flying particles of metal. It was necessary to make these glasses



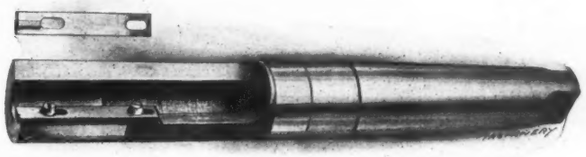
Willson Safety Goggles for Machinists and Grinding Machine Operators

quite heavy, owing to the nature of the service for which they were intended; and to guard against injuries resulting from broken glass, a safety flange was provided to prevent the glass from being driven inward in the event of either of the lenses being broken by flying chips of metal. For such work as operating grinding machines where there is no danger of the glasses being broken, the weight of the type of glasses referred to was found to be an undesirable feature; and for use in such work, T. A. Willson & Co., Inc., Third and Washington Sts., Reading, Pa., has placed a new goggle of somewhat similar design upon the market.

The frame is made in such a way that the goggle is light in weight although quite substantial, so that it will stand rough shop usage. An adjustable bridge enables the wearer to fit the goggles easily to his face; this bridge is pliable and securely attached to the "eye wires." The bridge does not touch the top of the nose, the weight of the glasses being distributed over the sides of the nose and the cheeks, and the goggles can be worn over spectacles. The guards to prevent flying particles of dust and grit from entering the workmen's eyes around the sides of the glasses are of fine wire mesh and add very little to the weight of the goggles. A fine quality of glass is used to insure freedom from eye-strain. The frames are made of rust-proof metal so that the goggles may be thoroughly sterilized before being given out to another workman. The "temples" are placed outside the side guards and fold over the front of the glasses. A case is provided with each set of these goggles.

TRIANGULAR CORE DRILL

The latest product of the Triangular Tool Co., Erie, Pa., is the core drill for extracting test "coupons" for use in making tensile or bending tests of material. The feature of this tool is the inserted cutter which may be adjusted to compensate for wear and can be readily replaced instead of grinding down the end of the tool itself. The cutter holder is made of heat-treated chrome-vanadium steel to enable it to stand up under hard service. The cutter is of high-speed steel. This tool will core out a piece in from 20 to 25 minutes without requiring the tool to be withdrawn to clear out the chips. In using this tool, it is recommended to employ a speed of about 25

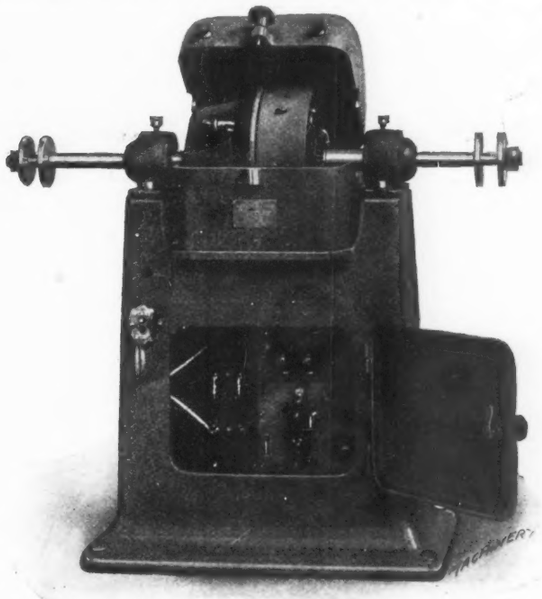


Triangular Core Drill for taking Test "Coupons"

revolutions per minute with a feed of 0.010 inch per revolution when working in high-carbon steel, while in low-carbon steel a speed of 50 revolutions per minute with a feed of 0.005 inch per revolution will be found satisfactory. The drill has a No. 5 Morse taper shank and two cutters are provided with it.

SPRINGFIELD BALL BEARING BUFFING MACHINE

A recent addition to the line of the Springfield Mfg. Co., Bridgeport, Conn., is the style BM motor driven ball bearing buffing machine which is illustrated herewith. This machine is driven by a Westinghouse type S. K. interpole commutating motor which delivers 3 horsepower and runs at 2200 revolutions per minute. Referring to the illustration, it will be



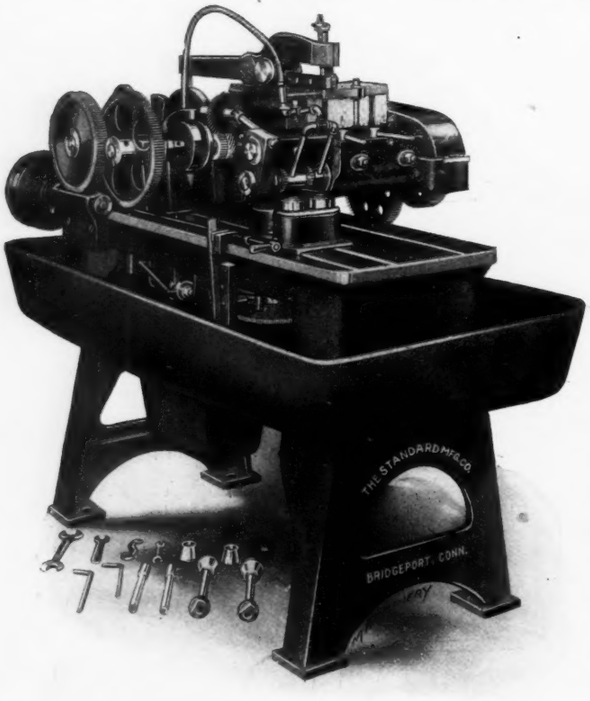
Springfield Buffing Machine with Motor Cover Raised and Door in Base Open

seen that push-buttons are provided for starting and stopping the machine. The motor is of standard design with the exception of the armature shaft which is made of high-carbon steel and of sufficient length and diameter to meet the requirements of the machine it is to drive.

The motor is rigidly bolted to the frame of the buffer and is enclosed in a dust-tight case; the upper half of this case is mounted on hinges and by loosening the thumb-screw at the front, it can be thrown back to expose the motor for inspection or adjustment, as shown in the illustration. An opening is also cast in the base below the motor which is covered with fine-mesh wire gauze. The bearings are bronze bushed and of the ring oiling type. The principal dimensions of the machine are as follows: Size of wheels, 12 by 2 inches; height to center of spindle, 36 inches; floor space occupied, 21 by 48¼ inches; weight of machine, 1250 pounds.

STANDARD MANUFACTURING MILLING MACHINE

The No. 3 automatic manufacturing milling machine which is here illustrated was designed for machining four-jawed, square jaw clutches. Two of these pieces are milled simultaneously, and in handling this work the operation of the machine is entirely automatic. The problem of milling these parts presented some difficulty owing to the fact that the cut is off center and that the sides of the slots converge toward the center of the clutch disk. After the first cut is made on both pieces mounted on the table of the machine, the work is indexed through one-quarter revolution and the second cut is taken, this process being continued until four cuts have been made in both of the pieces. The work is then indexed through an amount sufficient to bring it into the required position to mill the other side of the slots, and at the same time the cutters themselves are moved over to the opposite side of the center line. Four more cuts are then taken, thus machining the opposite sides of the slots. The entire operation is done automatically. Many varieties of manufacturing milling operations are done on these machines, including such work



Standard Manufacturing Milling Machine for cutting Square Jawed Clutches

as cutting various forms of gears, ratchets, sprockets, saws, cutters, knurls, taps, etc.

The cutter spindle of the machine is made of hardened and ground tool steel and has a long taper bearing which provides ample compensation for wear. The spindle may either be driven direct or through the back-gears and is carried by a slide having vertical movement, which, in turn, is carried by a slide that provides horizontal movement. By means of these two slides any combination of vertical and horizontal movement may be obtained. The cam-shaft is mounted at the rear of the machine and is driven through a worm and worm-wheel. This shaft carries the stroke cam, the cut cam and the index cams. This machine is made by the Standard Mfg. Co., Bridgeport, Conn.

"AVEY" BALL BEARING DRILLING MACHINE

The No. 2½ high-duty ball bearing drilling machine which is illustrated and described herewith is one of the recent additions to the line of the Cincinnati Pulley Machinery Co., Cincinnati, Ohio. This machine is built with either plain hand feed, or with power feed and means for automatically

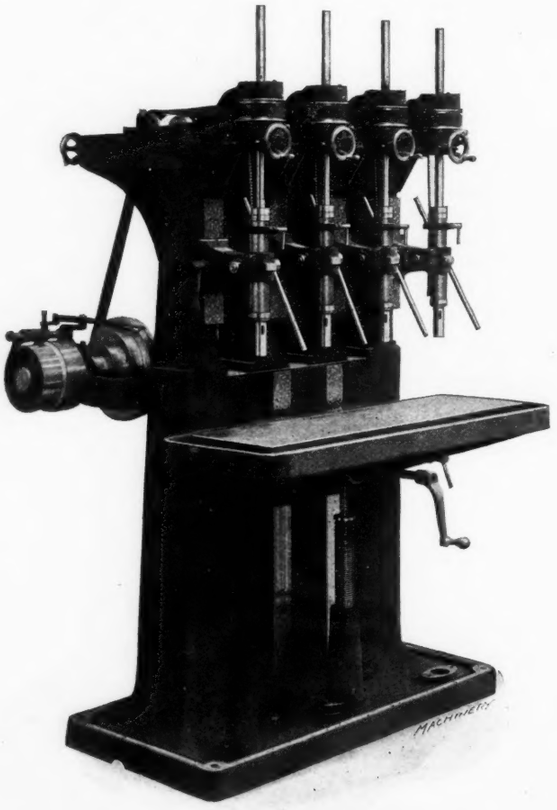


Fig. 1. "Avey" No. 2½ Ball Bearing Drilling Machine

reversing the travel of the drill in one or both directions. The machine with the automatic feed mechanism is very flexible, it being possible to operate it as a fully automatic or as a semi-automatic machine, or the automatic mechanism can be entirely disconnected and the machine fed by hand. As there are many factories which have certain pieces that they manufacture in quantities, and which can be handled rapidly, the problem of getting such pieces into and out of the jig is quite simple, and for drilling this kind of work all of the automatic mechanism on the machine is employed.

For classes of work which are more or less difficult to handle, more time will be required between successive strokes of the drill, and in handling such work the automatic trip for the down feed of the drill is thrown out, so that the return of the spindle is still taken care of automatically but the power feed clutch must be thrown in by hand. For other classes of work all of the automatic movements are disconnected and the drill is fed by hand. The stop collar on the spindle sleeve can be so adjusted that there is very little time wasted between successive operations of the drill; but on the other hand, if the work is of a character which requires considerable time to set up, the stop collar can be set in a po-

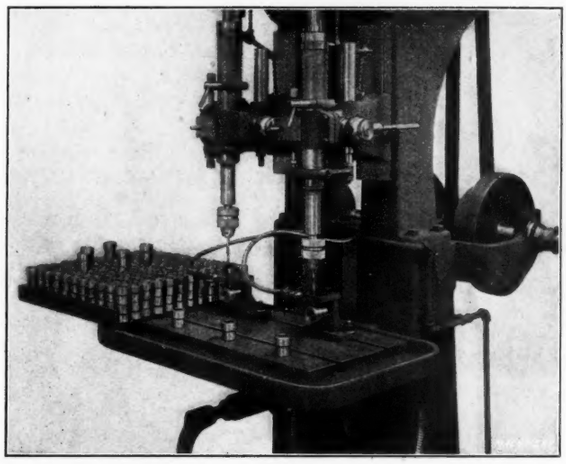


Fig. 2. Machine set up for drilling Steel Bushings—Production 10,000 per Day

sition which allows the spindle to feed down for some distance before it engages the work. Four spindle speeds are obtainable, the highest of which should not exceed 3000 revolutions per minute, and three changes of feed are provided, which are 0.005, 0.008 and 0.012 inch per revolution of the spindle. Different feeds can be furnished to meet the requirements of different classes of work.

The principal dimensions of the machine are as follows: Spindle bore, No. 2 Morse taper; diameter of spindle, 1 inch; width of belt, 1½ inch; height of machine to top of spindle cone, 79 inches; total traverse of spindle, 13¾ inches; distance from center of a spindle to column, 7½ inches; distance between spindle centers, 10 inches, and maximum distance from spindle to table, 33½ inches. An idea of the rate at which work can be drilled on this machine will be gathered from the following: A steel bushing with a wall 9/32 inch in thickness had to have a 17/64-inch hole drilled through the wall. These pieces were turned out by an unskilled operator at the rate of 1186 per hour. Allowing for changing drills and other unavoidable losses of time, it is safe to say that the daily production during a working day of ten hours would be 10,000 pieces. For drilling steel, a pump and piping is provided to deliver lubricant to the tool.

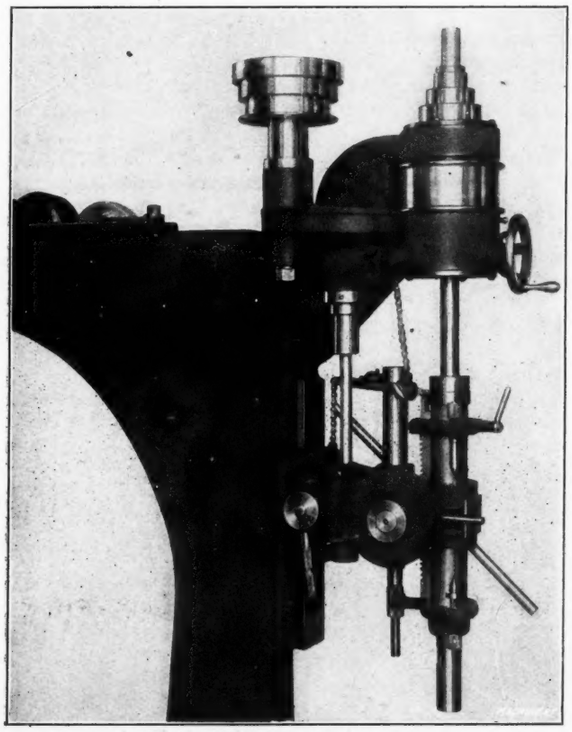
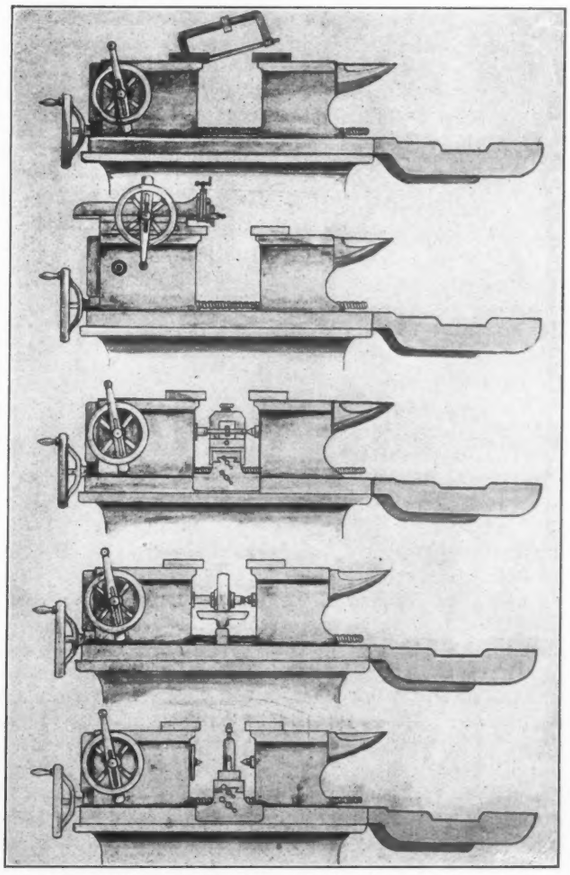


Fig. 3. Arrangement of Feed Mechanism

RAY MULTIPLE MACHINE

The Ray Mfg. Co., 247 Monroe Ave., Grand Rapids, Mich., has recently placed on the market a machine which comprises a lathe, drill press, shaper, milling machine, grinding wheel, hacksaw, forge, anvil and vise in a single unit. This machine is particularly intended for use in trade schools where students may become familiar with these types of equipment before starting work on high-class machine tools which might readily be damaged. Garages and small machine shops will also find it well adapted to their needs.

The forge receives the air blast from a small fan located inside the head, this fan being driven by the handwheel located at the front of the machine. The same handwheel drives the spindle in which the milling cutter arbor, drill, chuck or center and faceplate are held. The anvil is made from a steel casting and a fiber shim is placed between the anvil and bed of the machine in order to prevent vibration from crystallizing the metal. The anvil is also used as one member of the vise and is drawn along the bed by a screw operated by the handwheel at the end of the machine. The two handwheels govern all movements of the machine, but if



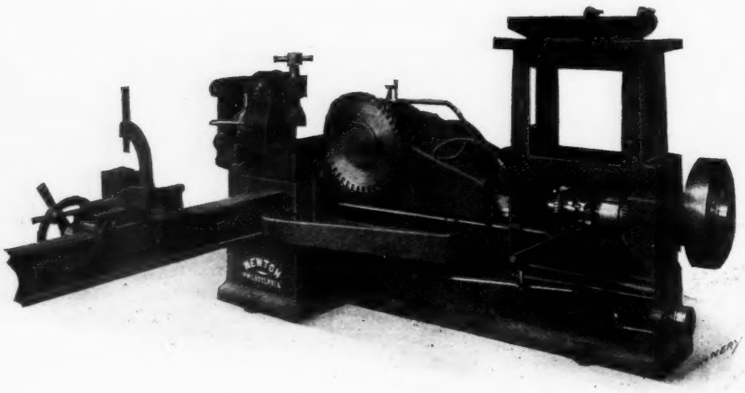
Ray Multi-purpose Machine for Trade Schools, Garages, etc

so desired, a motor can be employed for driving the geared head.

This machine is provided with or without a stand and is portable—a feature which makes it particularly useful in many shops where it is more convenient to take the machine to the work. The low cost of this machine should enable it to command a market in many shops where a cheap, general purpose tool is required.

NEWTON 22-INCH COLD SAW

The milling saw for cutting off bar stock which is illustrated herewith, is a recent product of the Newton Machine Tool Works, Inc., Philadelphia, Pa. The machine is equipped with a saw 22 inches in diameter and has a maximum capacity for stock up to 3½ inches in diameter. It is equipped with an air-controlled clamp and stock trolley provided with a



Newton 22-inch Milling Saw for cutting off Stock

length duplicating gage; and all operations necessary between making consecutive cuts are performed in fifteen seconds.

The saddle of the machine is of box type construction and provided with underlocking gibs which are cast solid with the saddle. Horizontal adjustments are made by means of tapered shoes. Geared feed is provided from a feed-box in which the arrangement of sliding gears enables any combination to be instantly obtained without the removal of gears. Provision is made for controlling the machine from either the front or the rear, which adds greatly to the convenience of operation. In addition to hand adjustment and power feed, the saddle has power quick return. Adjustable automatic safety release for the feed and fast power traverse, are provided.

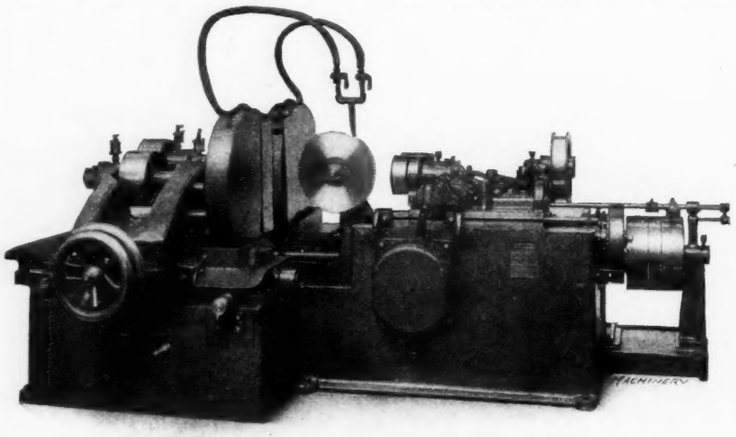


Fig. 1. Front View of Springfield Circular Saw Grinder

A lubricating system is provided which delivers a copious flow of cutting compound, and the base of the machine is designed to take care of the overflow, the reservoir being located in the base at the rear. The illustration shows the machine equipped for belt connection to an individual motor mounted on top of the pedestal, but a countershaft could be employed in cases where individual motor drive is not desirable.

An idea of the capac'ty of these machines may be gathered from the fact that running under actual shop conditions it has been found possible to cut off annealed stock 3½ inches in diameter, containing 0.70 per cent carbon and 0.70 per cent manganese, at a rate of thirty pieces per hour. Running at this rate the machines have been operated continuously for over fifty hours, which means that they will have cut off over 1500 pieces.

SPRINGFIELD CIRCULAR SAW GRINDER

The Springfield Mfg. Co., Bridgeport, Conn., has recently added to its line a machine for the purpose of grinding the clearance or taper on circular saws, blanks or disks up to 36 inches in diameter. Both sides of the work are ground simultaneously so that economical operation is obtained. This machine is also adapted for grinding work with parallel faces. The saw or disk to be ground is loosely mounted on a stationary arbor and rotated by two power-driven rolls which engage the work on each side and are held in contact with it by spring tension. The rolls are driven by a belt from the countershaft, the power being transmitted to the rolls through a train of gears. The rolls revolve at constant speed and the studs on which they are carried, are mounted in slides arranged in such a way that they may be separated by means of an eccentric and hand lever to provide for entering the saw. By traversing these rolls back and forth parallel with the face of the saw, a uniform speed is obtained. This traversing movement of the rolls is automatically controlled by tripping dogs which are set according to the size of the work; the same dogs govern the travel of the grinding wheel heads.

Provision is made for stopping the wheel heads at the end of their stroke to allow a few extra turns of the saw to be made in order to obtain a clear grinding cut against the shoulder. The grinding wheels are driven from a drum on the countershaft. They are mounted on high-carbon steel spindles which run in large bronze bearings. The heads are long but narrow and provided with taper gibs for taking up wear. They are mounted on a cross-slide of ample proportions and provision is made for swiveling the heads to obtain the required taper on the work. An adjusting screw facilitates setting for any desired taper or clearance of the saw that is to be ground. The grinding wheels are fed in by hand and both wheels may be fed simultaneously or independently of each other, according to the requirements of the work. The bed is of heavy box section reinforced by cross ribs. A pump is provided which supplies a copious stream of water or cooling compound to the work, the spray being caught by guards and returned to the overflow tank from which it is delivered to the pump tank. The principal dimensions of the machine are as follows: Largest diameter of saw that can be ground, 36 inches; size of grinding wheels, 20 by 3 inches; size of grinding wheel spindle bearings, 2⅞ by 6½ inches; diameter of saw driving rolls, 6 inches; floor space occupied, 6 feet 8 inches by 9 feet; weight of machine, 8000 pounds.

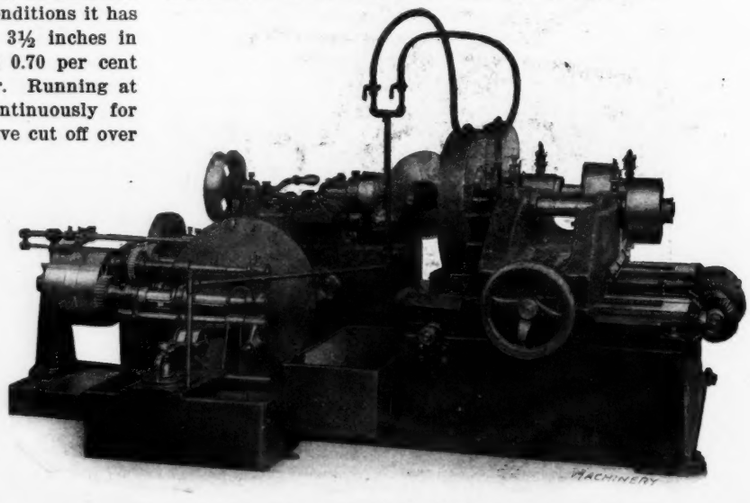
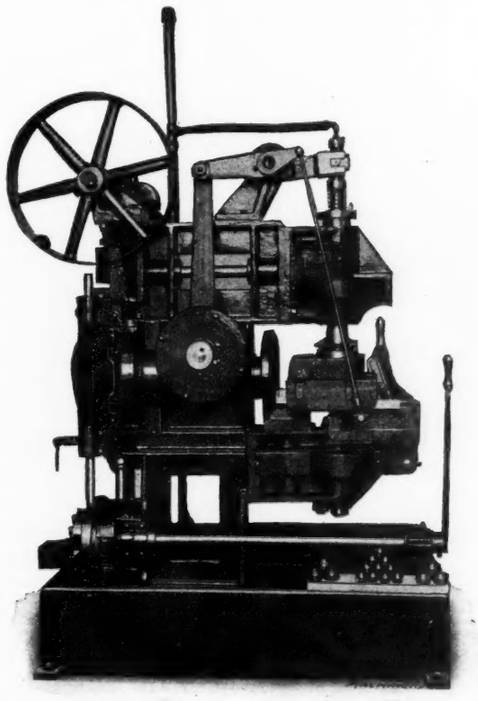


Fig. 2. Opposite Side of Springfield Grinder shown in Fig. 1

POTTSTOWN SEMI-AUTOMATIC UNION MACHINE

The machine here described is intended for machining malleable iron lip union heads and tails. It is built in combinations of any number of units up to four, which are mounted on a single base; in this way the requirements of different shops are met, and by having more than one unit under the control of a single operator, he is kept constantly busy. The work is chucked in a vertical position which makes it possible to equip the machine with a pump and piping that supplies cutting lubricant through the hollow upper spindle, thus flooding all tools, giving long life to the tools and a good finish to the work. This is also the means of enabling the highest possible speed to be utilized.

In operation, the fitting is clamped in the chuck and the machine started with the controlling lever, after which it passes through the cycle automatically, performing the operations of facing, under-cutting and tapping. When the fitting is finished, the machine comes to a standstill and the chuck is drawn back clear of the tools, after which the fitting drops through the back of the chuck into a receptacle placed to receive it. While the chuck is withdrawn, the next blank is placed between the jaws, after which the chuck is pushed up against a stop, thus gripping the work and bringing it into line with the spindles of the machine.

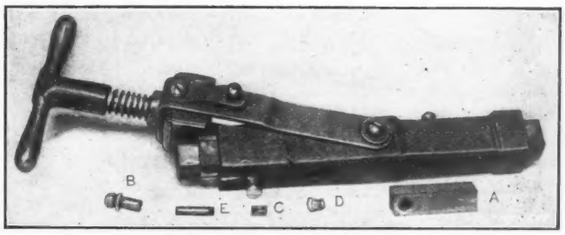


Pottstown Semi-automatic Machine for machining Unions

It has already been stated that the machine is controlled by a single lever at the front, and this lever makes it possible to stop the tools at any point of the cycle and return the machine to the starting point. In case a tool breaks, this lever makes it possible to stop the machine instantly, thus preventing further damage to the tools, which might occur if the machine were allowed to pass through an entire cycle before coming to a stop. The time required to finish a ¾-inch union is 20 seconds, while the finishing of a 1¼-inch union takes 30 seconds. This machine is the latest product of the Pottstown Machine Co., Pottstown, Pa.

MUELLER TELESCOPIC SOCKET WRENCH

The accompanying illustration shows a telescopic socket wrench which is made by Louis Mueller, 1719 Central Ave., Cincinnati, Ohio. This wrench is designed to take the place of the common type using a number of loose sockets, and it will handle all sizes of both hexagon and square nuts for ⅛ to ⅝ inch bolts. The telescopic feature eliminates the use of loose parts and makes a very compact tool.



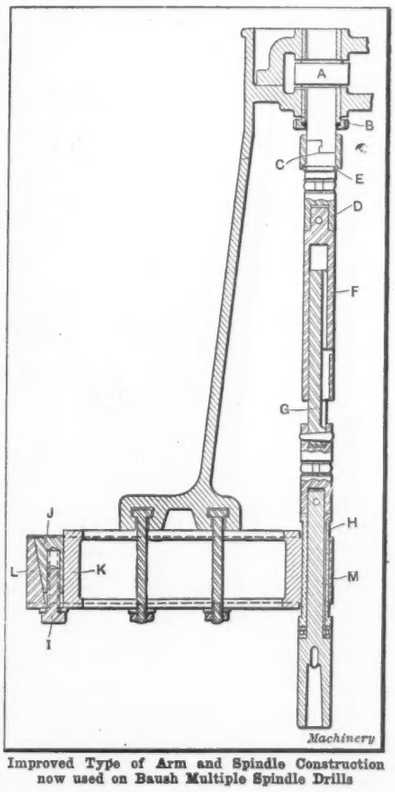
Mueller Telescopic Wrench and Some of its Parts

Referring to the illustration, one of the telescoping sockets is shown at *A*, the movement of the sockets being controlled by knobs *B*. These knobs are fastened to washers *C;* they work against the tension of springs *D* and are a sliding fit on pins *E* which are inserted crosswise in the sockets. To bring out any required socket, the knob *B* is pressed down until the flat portion just below the shoulder comes into line with the narrow slot *F* in the wrench; the knob can then be advanced to the next circular opening so that the socket is brought out ready for use. On relieving the pressure on the knob *B*, the spring *D* forces the knob out into the circular opening, thus holding the socket in place. The way in which the wrench is swiveled around to bring either end into action will be evident from the illustration.

IMPROVED ARM AND SPINDLE FOR BAUSH MULTIPLE DRILLS

The accompanying illustration shows an improved form of spindle and supporting arm construction which is now used on the multiple spindle drilling machines built by the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. Referring to this illustration, it will be seen that the spindle gear *A* is supported on both sides by long bronze bushings and the lower bushing is fitted with a packing nut *B* which forms an oil-tight joint around the bottom of the bearing. This makes it possible to keep the gear chamber filled with oil, thereby insuring perfect lubrication of the gears and bearings.

It is often desirable to remove one or more spindles from the head of a multiple drilling machine in order to facilitate the adjustment of the remaining arms. This is provided for in the improved Baush construction by the joint connection *C*, which makes it an easy matter to assemble or disconnect the spindle. This is done by removing the spring *D* to enable the collar *E* to be dropped down to expose the connection. To reconnect the spindle, it is merely necessary to pass the collar up into its original position and snap the spring *D* into place. The universal ball joint is



Improved Type of Arm and Spindle Construction now used on Baush Multiple Spindle Drills

of the improved Baush pattern made with a solid ball grooved at right angles, two sets of driving blocks and two sockets. With this construction a very simple but powerful joint is secured.

It will be seen that the spindle proper consists of two telescopic members *F* and *G* which are keyed together. This provides for adjustment of the length of the spindle when it is placed in various positions, and means of compensation for differences in the length of the drills. The drill socket bearing *H* is of bronze and has a vertical adjustment of 1¼ inch to further compensate for variations in the length of the drills. All drill sockets are fitted with standard Morse taper holes and are provided with ball thrust bearings.

The feature of the adjustable arm is the method of clamping the drill socket bearing in the desired position. To accomplish this it is only necessary to operate a single screw which is located at the outer end of the arm so that it is always accessible. This screw *I* draws down the wedge *J* which is held between the end of the arm *K* and the wedge block *L*. The wedge block is electrically welded to a piece *M* known as the clamping strip, which is a U-shaped member encircling the arm and bearing *H*, and has its outer ends connected to the wedge block *L*. When the wedge *J* is drawn down by means of the screw *I*, the drill socket bearing is securely clamped into a curved recess in the arm; and by loosening the screw the vertical adjustment of the drill socket is easily taken care of without disturbing the location of the arm which is attached to the head of the machine by two standard T-bolts. It will be evident that with this improved type of spindle and arm, a great saving of time can be made in disconnecting the spindle and making adjustments of the various spindles to take care of drills of different lengths.

SELLEW ADJUSTABLE DRILL HEAD

The Sellew Machine Tool Co., Pawtucket, R. I., has recently placed on the market another type of adjustable drill head in which all of the gearing is completely enclosed. This head has spindles which may be adjusted to provide for multiple drilling or tapping operations on circles of different sizes. The head is especially suitable for machining such parts as electric motor frames, gaskets, flanges, pipe glands, etc. The spindles are mounted eccentrically in plates which may be revolved about their centers in order to adjust the spindles to any position within the range of the head. Figs. 1 and 2 show the heads with the spindles set at the two extreme positions of their range, and the way in which the adjustment is made will be readily understood by referring to the illustration of the under side of the head shown in Fig. 2. The edges of the plates in which the spindles are mounted are graduated in such a way that they may be quickly indexed and clamped in position to locate all of the drills on a circle of a given diameter and to have all of the spindles equally spaced according to the number of spindles in the head. This design not only makes it possible to totally enclose the gearing to provide for the safety of the operator and to have the gears flooded with oil, but it also makes a very rigid construction which overcomes any strain due to the pressure of the feed.

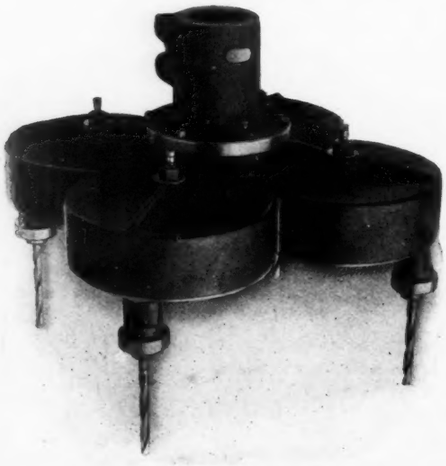


Fig. 1. Top View of Sellew Drill Head

The head is connected to the drilling machine quill by means of a flanged sleeve. The regular tapered driving shank drives the center gear of the head which meshes with intermediate gears around which the spindle pinions are adjustable. While the connecting sleeve clamp and the quill hold the head in perfect alignment with the machine spindle, additional support is afforded at the lower end by means of a long bearing for the tapered driving spindle in the head. This center driving spindle is also arranged with a tapered hole the same as that of the drill spindle, so that a center hole can be drilled at the same time that the spindles in the head are working. Using an arbor with a pilot, the work or jig can be revolved, facilitating the indexing of the work where a large number of holes are to be drilled in multiples of the number of drills in the head. The connecting sleeves and driving shanks are interchangeable so that the same heads may be used on different sizes or makes of machines. The gearing and spindles are of alloy steel and the spindles are equipped with ball bearings. Heads of this type are made with up to six spindles. With the smallest size of head, the spindles may be adjusted as close as 1 inch, while the maximum range of the largest size of head is a circle 24 inches in diameter. The accompanying illustrations show a head which may be adjusted between circles 6 and 24 inches in diameter.

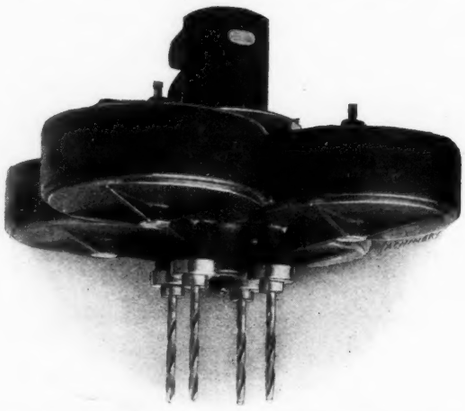


Fig. 2. Under Side of Drill Head showing how Adjustment is made

CORRECTION

In the description of the New Britain buffing lathe made by the New Britain Machine Co., 64 Bigelow St., New Britain, Conn., in the November number of MACHINERY, an error was made in stating that it was necessary to pull up the handle in order to raise the pivoted head to bring the driving belt into contact with the pulley. To raise the head for this purpose the handle is pushed down. The illustration presented in connection with this description showed the machine in the stopped position instead of in the operating position, as stated.

NEW MACHINERY AND TOOLS NOTES

Friction Clutch: Holyoke Machine Co., Worcester, Mass. This clutch is of the rim friction type, there being a complete circle of frictional contact of wood on iron. The shoes are easily removed so that the replacement of the wooden frictions is easily effected.

Bending Brake: Dreis & Krump Mfg. Co., 2909 South Halstead St., Chicago, Ill. A motor-driven bending brake which has a capacity for handling plates up to ½ inch in thickness and up to 16 feet in length. The machine is driven by a 20-horsepower electric motor.

Hydraulic Press: Metalwood Mfg. Co., Detroit, Mich. A self-contained hydraulic press adapted for general machine shop work where forced fits have to be made. The machine consists of a stationary base and a head cast integral with the hydraulic cylinder, the two members being held together by tie-rods.

High Pressure Gas Cylinder Stud Valve: International Oxygen Co., 115 Broadway, New York City. A stud valve for use on high-pressure gas cylinders which is adapted for withstanding pressures up to 2500 pounds per square inch. The valve is especially suitable for use on cylinders containing oxygen, hydrogen and similar gases.

Pocket Calculator: Small, Small & Co., Waltham, Mass. A small pocket calculator which is the equivalent of a 6-inch logarithmic scale arranged in circular form. The instrument can be used for a great variety of calculations which are handled on the ordinary slide rule and is convenient to carry, owing to its exceptionally compact form.

Casehardening Compound: German Compound Co., 151 Franklin St., Boston, Mass. Hardening and carbonizing compounds which, when sprinkled on red hot steel, provide for carbonizing to a depth of 1/64 inch. In addition to the rapidity with which this can be used, it is said that very little smoke or objectionable gas is given off.

Crane Controller: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. A line of magnetic switch controllers in which overload protection is provided for by means of two overload relays, one of which is located on each side of the line. After the relays have operated, they are automatically reset by throwing the master switch to the off position.

Rail Hacksaw: A. Reitlinger, 170 W. Broadway, New York City. A portable machine for cutting rails. The machine is clamped to the flange of the rail and the cut started at the bottom. It is operated by a handle which is provided with a knuckle joint so that it may be swung down to allow a train to pass over the machine without removing it from the rail.

Safety Lathe Dog: Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill. A lathe dog which combines convenience and efficiency with protection for the machine operator. The head of the binding screw is covered with a special shield which prevents the possibility of the operator's hands being cut or his clothing caught by the head of the screw.

Oxy-acetylene Welding Outfit: Willners Machine Co., Chicago Heights, Ill. An equipment in which the acetylene generator is of the type in which the gas is rendered non-explosive by mixing it with oil gas. The acetylene and the oil gas are generated simultaneously and in addition to being suitable for welding and cutting operations, the gas may be used for lighting, heating, etc.

Shear: Cleveland Punch & Shear Works Co., Cleveland, Ohio. Heavy-duty plate shears built for the Riverside Works of the Otis Steel Co., Cleveland, Ohio. One machine has a capacity for cutting 1¼-inch plates 84 inches in width; and the other two machines have a capacity for shearing plates 156 inches in width, one of these machines accommodating 1-inch stock and the other ¾-inch stock.

Tire Heater: Hauck Mfg. Co., 140 Livingston St., Brooklyn, N. Y. A portable machine which can be easily set up at any point where work is to be done. The apparatus consists of a cast-iron combustion chamber provided with eight burners leading to the tire. The burners are equipped with adjustable sleeves to adapt them for the requirements of different sizes of work. Kerosene oil is burned in the heater.

Multiple Spindle Drill: National Automatic Tool Co., Richmond, Ind. In the August, 1914, number of MACHINERY, the "Natco" No. 20 high-speed multiple drill of this company's manufacture was illustrated and described. Since that time, the National Automatic Tool Co. has brought out a No. 22 machine which is heavier and more powerful but otherwise similar in design. The chief points of difference between these two machines are that the No. 22 will carry a larger size of head with more spindles, and that the table is correspondingly increased in size to provide for handling larger work. The feed box and feed mechanism below the table are also of somewhat different construction.

Horizontal Multiple Spindle Drill: Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. In the November number of MACHINERY, reference was made to the special multiple spindle drilling machine built by this company for drilling all of the holes in an automobile transmission case without requiring the work to be reset. This is a special purpose machine on which two opposed horizontal heads and one vertical head are provided. The Baush Machine Tool Co. has recently developed a machine of this type on which there are two opposed horizontal heads, which are adapted for meeting any conditions where drilling is to be done on both sides of a piece of work. In other words, this is a universal machine, while the former machine was built for a special class of work.

Multiple Spindle Drills: Rockford Lathe & Drill Co., Rockford, Ill. In the February, 1914, number of MACHINERY the two-spindle sensitive floor drill manufactured by the Rockford Lathe & Drill Co., Rockford, Ill., was illustrated and described. This company has recently brought out machines of the same type equipped with three and four spindles. In designing these machines particular care has been taken to make the design and method of operation as simple as possible. The column is of the box type, braced in such a way that exceptional rigidity is secured. The table is raised and lowered by a handwheel; adjustable supports are provided, and the table may be removed for refinishing, should it become badly worn. The spindles are provided with ball thrust bearings and stop collars.

Pipe Machine: Williams Tool Co., Erie, Pa. A motor-driven 16-inch pipe threading and cutting-off machine. The driving motor is mounted on an auxiliary base at the rear of the machine and direct connected. In other respects this machine is the same as the 16-inch machine of this company's manufacture which has been on the market for about a year. This machine cuts off and threads pipe from 7 to 16 inches in diameter. The die head is carried on a sliding carriage and is furnished with eight sets of interchangeable dies which are operated by a handwheel. There are four changes of spindle speed, these changes being controlled by levers on the operating side of the machine. The spindle is equipped with a powerful three-jaw chuck on both ends; the rear chuck is fitted with flange grips for making up flanged work.

* * *

PORTABLE COMPRESSED AIR PUMPS

Compressed air leaks rapidly through minute openings, and leakage losses are one of the serious troubles met with in all compressed air installations. Were it not for the fact that the waste of compressed air is so great wherever leakage exists, its use would undoubtedly be much more extensive in machine design than it now is. One method of overcoming the trouble is to do away with the common system of stationary air compressor and distributing pipes, and to furnish the compressed air where required as it is needed, by means of a portable air compressor. This is being done to some extent in garages for inflating tires, etc. Instead of installing a stationary compressor and lines of piping with vents at various points for the convenience of the garage workman, a portable compressor driven by an electric motor is furnished. This compressor, weighing but a few pounds and mounted on wheels, can be quickly taken to any place in the garage and there connected to a convenient lamp socket. It pumps air in any quantity required to a pressure of 100 or 125 pounds per square inch, and as soon as the need is filled, the electric current is shut off and all waste stops.

The same principle is being employed to a considerable extent for hydraulically operated machines. Instead of having a central pumping plant and a costly accumulator and pipe system, each press or other machine is provided with its own hydraulic pump and electric motor. The motor and pump supply water under pressure to the hydraulic system as required, and the moment the need ceases pumping is discontinued. The advantages of this system are flexibility, low cost of up-keep and simplicity of installation.

* * *

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The annual meeting of the American Society of Mechanical Engineers will be held at the Engineering Societies Bldg., New York City, December 1-4. The tentative program includes the following papers:

Floor Surface in Fireproof Buildings. By Sanford E. Thompson.

Reinforced Concrete Factory Buildings. By F. W. Dean.

Measuring Efficiency. By H. L. Gantt.

Standardization in the Factory. By C. B. Auel.

Operation of Grinding Wheels in Machine Grinding. By George I. Alden.

Friction Losses in the Universal Joint. By P. F. Willson and W. J. Malcolmson.

Steam Locomotive of Today. (Sub-committee Report.)

Factors in Estimating Tool Steel. By John A. Mathews and Howard J. Stagg.

Standardization of Chilled Iron Crane Wheels. By F. K. Vial.

The Mechanical Elimination of Seams in Steel Practice, Notably Steel Rails. By R. W. Hunt.

The Rate Flow Meter. By H. C. Hayes.

A New Volume Regulator for Air Compressors. By Ragner Wikander.

Physical Loss of Methane Gas. By P. F. Walker.

Lubricating for Testing and Investigating Liquid Flow Meters. By W. S. Giele.

The Clinkering of Coal. By Lionel S. Marks.

The John Fritz medal will be awarded to Prof. John E. Sweet, honorary member and past president of the society, Wednesday evening, December 2, with appropriate ceremonies.

NEW PLANT OF THE BROWN INSTRUMENT CO.

Users of Brown pyrometers and Keystone electrical instruments will be interested in learning that the Brown Instrument Co. and the Keystone Electrical Instrument Co. are now located in their new factory at Wayne Junction, Philadelphia,

Fig. 1. View of Machine Shop in New Factory of the Brown Instrument Co.

Pa. The factory is a new two-story brick building in which the manufacturing department is located on the second floor, while the first floor is given over to the office, the receiving and shipping rooms, and to a locker and wash room for employes.

In laying out the equipment in the manufacturing department, the arrangement has been worked out so that the work passes in a continuous circuit, thus avoiding unnecessary loss of time in transit. The inspection department is located at the center of the floor, the machine shop being located on one side and the assembling department on the opposite side. Windows communicating with both departments are provided so that the inspectors can receive work from either the machine shop or the assembling room. All work receives a double inspection. Parts made in the machine shop are handed in through the window of the inspection department where they are looked over to make sure that they fulfill all requirements, after which they are passed on through the window at the opposite side to the assembling department, where the work of putting together the component parts of the instruments is handled. After each instrument is finished in the assembling department, it is sent back to the inspection room where it is carefully tested before being shipped.

Figs. 1, 2 and 3 show views in the machine shop, the inspection department and the assembling department, respectively. In reference to the machine shop it may be stated that the most modern forms of equipment are provided for handling the light machining operations involved in the manufacture of this company's product. On the left-hand side of the view of the inspection department, the work of testing pyrometer couples is shown. For this purpose five of the couples to be tested are placed in a furnace with a standard couple which has been calibrated by the Bureau of Standards, Washington, D. C. The temperature of the furnace is gradually raised and the indications of each couple are compared with that of the standard couple by means of a switch which enables first the standard couple and then the couple which is to be tested, to be connected with the indicating instrument. Any inaccuracies which are discovered in this way are corrected and subsequent tests are made until the required degree of accuracy has been obtained.

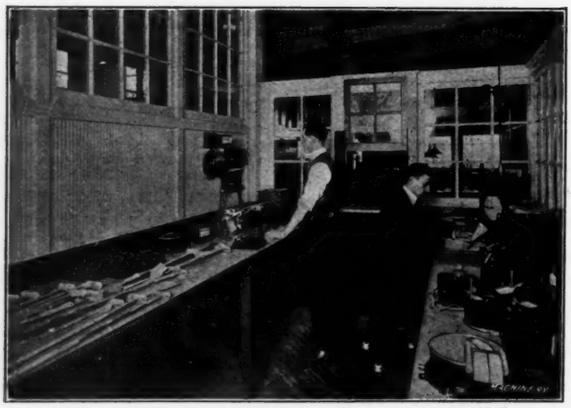


Fig. 2. Inspection Department—testing the Accuracy of Pyrometer Couples

Fig. 3 shows a general view of the assembling department from which an idea of the layout of the equipment can be obtained. In assembling the fine mechanism which forms a part of the Brown and Keystone instruments, it will be evident that good light is an essential feature in securing satisfactory results. This requirement is well taken care of in the new factory by having the work benches run around the sides of the room where advantage may be taken of natural light afforded by an ample window area. The most modern means of artificial illumination also forms part of the equipment, so that the work need not suffer on dark winter afternoons.

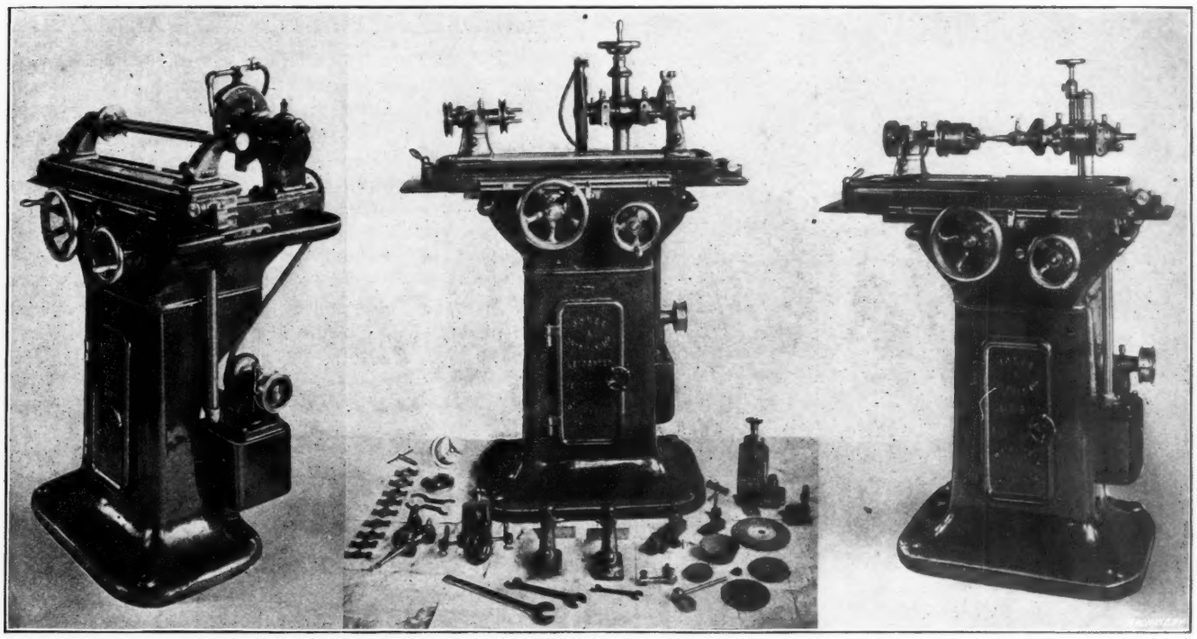
It has already been mentioned that after the work is finished in the assembling department, it goes back to the inspection department where the accuracy of each instrument is finally determined before it is sent to the customer. After being passed by the inspector, the work is sent down to the shipping room on the main floor. On this floor there is also a room equipped with sanitary wash basins and metal lockers. Each employe has an individual locker. In going through this factory, the visitor is impressed by the fact that the building and its equipment, and the despatch and care with which the work is handled and passed from department to department, is all that he should expect to find in a plant given over to the manufacture of high-grade scientific instruments.

Fig. 3. General View of Assembling Department

* * *

ON SPECIALIZATION IN MANUFACTURE

The degree to which specialization of manufacture is carried on in the United States is to some extent indicated by the fact that there are several concerns making brass and bronze bushings for bearings. One concern making a specialty of this line has been in business for seven years. It was organized with the idea of specializing in bearing metal, as the founder saw an opportunity in this line owing to the fact that the average engineer or designer is not as familiar with the different characteristics and properties of bronzes as he is with other metals. This concern ships from 5000 to 15,000 finished bushings a day, costing from 5 cents to $12 each. It is an organization of bushing makers, trained to produce this one line who devote all their time and energy to it exclusively. The result is that the company can furnish the average manufacturer bronze bushings and bearings costing from 25 to 50 per cent less than his own cost. Besides saving money, he obtains a much higher grade of article than is made in the average shop. The concern in question issues a price list in which 1300 standard sized bushings are listed.



Figs. 1 to 3. "New Century" Plain and Universal Grinders, and Application of Internal Grinding Attachment

"NEW CENTURY" CYLINDRICAL GRINDER

The "New Century" cylindrical grinder which is illustrated and described herewith is one of the recent products of Jones & Shipman, Ltd., Leicester, England. The machine is adapted for both internal and external cylindrical grinding and the design has been worked out along lines which provide for the rapid production of accurate work. The machine is suitable for manufacturing operations and is adapted to requirements of repetition work. It will be seen from Fig. 1 that the column is of massive rectangular construction, and the base has a three-point bearing contact with the floor. The slides are constructed so that the working surfaces are always covered and automatic spring roller lubricators supply the oil to the slide-ways. The table and slides are held down by their own weight, obviating the friction incident to the application of bottom guides and "keep" plates. The top table has a front edge machined perfectly true and all attachments are made with faces to correspond; by means of an angular slot and locking device the attachments are always pulled up securely to this master face on the table, thus insuring perfect alignment. The top table may be rotated to provide for grinding tapered work.

The head has been carefully designed for operation at high speed, the spindle being accurately ground and fitted in adjustable phosphor-bronze bearings which are dust-proof and self-oiling. The head is a heavy box section casting which is bolted to the cross-slide, and the ways of the cross-slide are always covered and protected from dust. Fig. 1 shows the plain grinding machine, the universal grinder is shown in Fig. 2, and in Fig. 3 the machine is shown set up for an internal grinding operation. The universal machine is well adapted for tool-room work and the attachments and various parts provided for use in connection with it are shown in the illustration. Three of the fixtures for the universal machine are shown in operation in Figs. 4, 5 and 6. In Fig. 4 the universal V-clamp fixture is shown. This fixture is adapted for handling various classes of work and can be swiveled to meet the requirements of different operations. Fig. 5 shows the universal swivel vise in which work is held for surface grinding operations. It will be seen that this vise is provided with two swivels and graduated dials which enable the work to be set for grinding any angle.

In Fig. 6 the gear cutter dividing head is shown set up on the machine. In grinding a cutter on this attachment, an index plate having the same number of divisions is mounted at the opposite end of the mandrel from the work. This index plate has notches which are engaged by a spring plunger to locate the work for grinding successive teeth. Other fixtures for use on this machine include a twist drill grinding fixture which is attached to the cross-slide, a fixture for taper shank cutters which consists of a hollow spindle bored No. 4 Morse taper, with collets to take Nos. 1, 2 and 3 Morse tapers, a high-speed internal grinding attachment which gives speeds up to 40,000 revolutions per minute, centers to carry cylindrical work up to 12 inches in diameter, and a special fixture

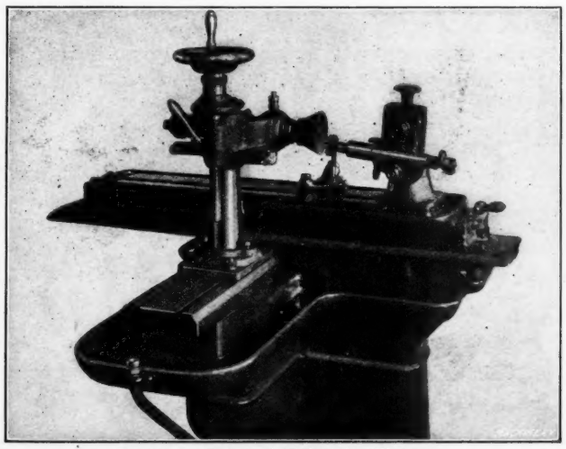


Fig. 4. Universal V-clamping Fixture

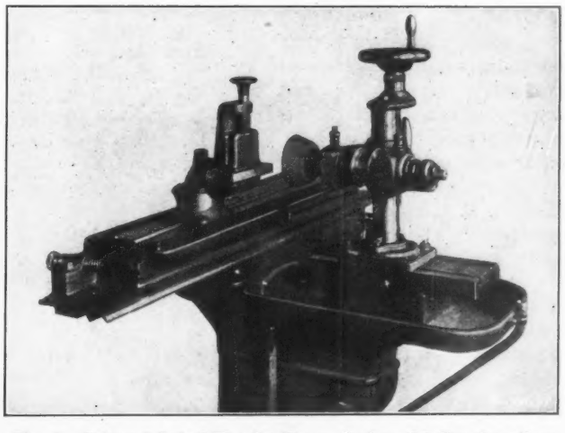


Fig. 5. Universal Swivel Vise for Use on Surface Grinding Operations

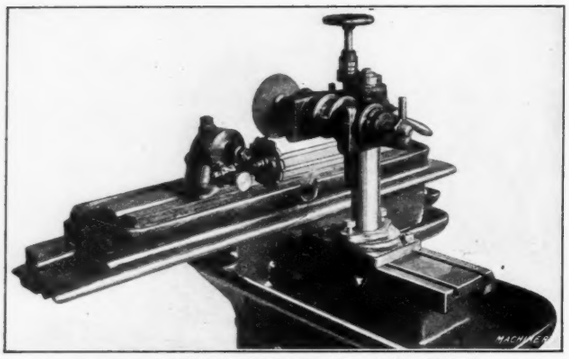


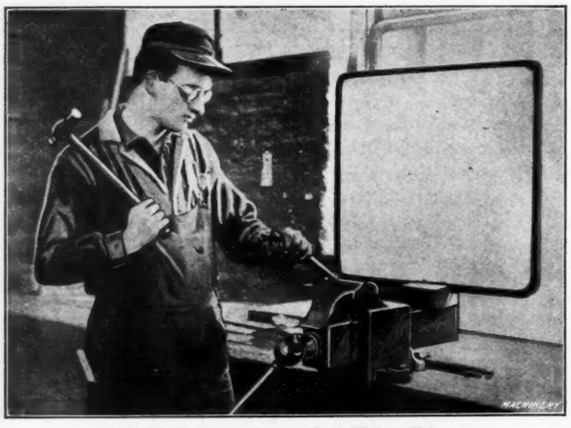
Fig. 6. Dividing Head for Use in grinding Cutters

for grinding the sides of saws, cutters, collars, etc. The principal dimensions of the machine are as follows: Working surface of table, 27½ by 4 inches; longitudinal traverse of tables, 17½ inches; swing of centers, 8 inches; cross traverse of wheel slide, 5 inches; size of wheel used, 8 by ¾ inches; net weight of machine, approximately 800 pounds.

* * *

SHIELD FOR PROTECTION AGAINST FLYING CHIPS

The accompanying illustration, reproduced from the safety bulletin of the Illinois Steel Co., shows a shield for protecting workmen from flying chips. It is an adaptation of the ordinary frame canvas shield, its peculiar feature being that it is mounted on an iron block of sufficient weight to hold the shield always in vertical position. No other support is required. Hence it can be moved around at will, placed almost anywhere on a bench or vise and at an angle, if desired.



Shield for Protection against Flying Chips

Another adaptation of the same idea is having the base to which the shield is attached fairly broad and heavy and rounded on the bottom so that if knocked over it will automatically return to an upright position.

* * *

HIGH CONDENSER VACUUM

Within recent years engineers have been striving for higher and higher vacuums in order to increase the efficiency of steam turbines, but it is only recently that the feat of obtaining a vacuum one per cent higher than the theoretical has been accomplished. A recent test made in the hydraulic laboratory of the Wheeler Condenser & Engineering Co., Carteret, N. J., on one of its turbo-air pumps, showed vacuums considerably higher than the theoretical for quantities of air up to about twenty cubic feet of free air per minute, when the vacuum fell to 100 per cent or the theoretical. The explanation of the paradox is that it is customary in condenser work to consider the vacuum corresponding to the temperature of the water passing through the pump. The hurling water is subjected to a cooling effect caused by the high vacuum and this reduces the temperature of the water and also reduces the vapor tension and increases the vacuum obtainable.

MANDREL FOR TURNING PARALLEL SURFACES

BY ARTHUR E. BLOFIELD*

Where it is required to turn two surfaces exactly parallel, the mandrel shown in Figs. 1 and 2 will be found very useful. This is nothing more than an expanding mandrel which is provided with an accurately finished shoulder, against which the work may be located. A small saw is shown mounted on the mandrel. If we assume that it is required to turn the two sides of this saw exactly parallel, the method of procedure followed would be to first turn one surface. The work would then be removed from the mandrel and the finished surface placed against the locating shoulder, after which the opposite side would be turned; and owing to the way in which the work was held while turning the second side, it will be evident that both sides would be exactly parallel.

The parts of the mandrel are shown in Fig. 2, and referring to this illustration in connection with the following description, the construction of this tool will be readily understood. It will be seen that the nut *A* has a fine thread cut on the out-

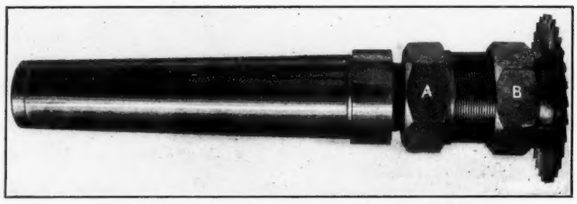


Fig. 1. Mandrel designed for Use in turning Parallel Surfaces

side of it, the nut *B* being threaded internally to screw onto the extension on the nut *A*. The nut *A* is also threaded internally, the thread being of the proper size to screw onto the threaded extension *C* on the mandrel. The split bushing *D* is carried inside of the extension on the nut *A* and is held in place by the small plate *E*, the edge of which fits into the annular groove in the split bushing *D*. A second split bushing *F* fits over the bushing *D*. In preparing to use the mandrel, the bushing *F* is slipped over the end of bushing *D* and the nut *B* is screwed onto the nut *A* to bring the locating shoulder to the required position. The work is next slipped over the bushing *F* and the nut *A* is then screwed back onto the mandrel to expand the bushings over the tapered pilot *G*, thus securing the work firmly in place. On relatively thin work, the internal pressure of the split bushings would be sufficient to cause serious distortion and inaccuracy, if it did not actually break the work.

To avoid this difficulty, a stop nut *H* is provided on the threaded extension *I* on the mandrel. The nut *H* is set in such a position that nut *A* can only be screwed back a specified distance, this distance being such that the internal pressure cannot be sufficient to damage the work. In addition to the particular purpose for which this tool was designed, it could be used for handling a variety of other classes of work for which an expanding mandrel is required.

* Address: 514 E. 78th St., New York City.

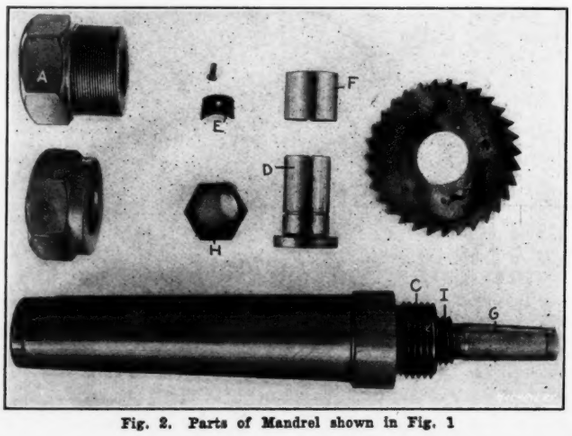


Fig. 2. Parts of Mandrel shown in Fig. 1

LOCATION AND DESIGN OF FACTORY BUILDINGS*

Factory design requires a broader knowledge of engineering than do most types of buildings. For this reason it is the work of an industrial engineer rather than an architect. The industrial engineer should be an engineer with a fair working knowledge of architecture, and of civil, structural, mechanical and electrical engineering. It is essential to the economical design of any building which is to house machinery and human beings doing work which involves repetition of the same act, that the designer of that building should have a very clear working knowledge of all the machinery installed and the processes which are to be carried on in the finished structure. The work of the industrial engineer should commence, if possible, before the location of the factory is determined upon. The first consideration is, of course, the proper locality for the industry. This is largely an economic problem which the engineer may or may not be required to study.

The cost of any manufactured commodity to the retailer consists of the following items: Cost of raw materials, cost of transportation of these raw materials to the factory, cost of labor on materials, cost of power, overhead charges, including interest on money invested, depreciation of plant, insurance, office time and advertising, cost of distribution, profit to the manufacturer.

It should be the duty of the engineer to study these items and to so arrange them that they will occupy their proper place, bearing upon the factory location. This place is, of course, different in different kinds of factories. In the fabrication of structural steel, for instance, perhaps the most important factor is freight. This includes freight from the rolling mill to the factory and freight on the finished product from the factory to the consumer. In some parts of the United States this freight amounts to more than half the cost of the finished product. However, in the manufacture of candy, for instance, the freight is of small importance and the proximity to the market and the cost of labor is of greater importance.

Having determined on the vicinity in which the factory is to be built, the next consideration is the purchase of the exact site necessary for the project. The exact area of land which is necessary is usually a troublesome question. Most successful projects are hampered by lack of room to provide for their growing needs. On the other hand, it is a serious handicap to a young industry to be burdened with heavy interest charges and taxes on land not at the time in use.

The size and shape of the area necessary for present needs is usually determined by making a preliminary plan of the whole project. With the approximate area required clearly in mind, a search of the locality will usually show a number of available sites. For projects of some importance, plats are usually prepared showing how the proposed sites may be developed. These plats should show the approximate grades and elevations of all adjacent streets, the location of sewer, gas, water and power connections and the available connection to adjacent railroads or sidetracks. At this time a study should be made to determine the number and length of sidetracks which will be required. In general, the track should be long enough to hold as many forty-foot cars as the company will need to load and unload in any one day.

After the exact location of the site is determined, the plans of the buildings must be prepared. It is, of course, a mistake to make the final plans of any building before its definite location is settled. The natural grades of the land itself, the streets, the points of the compass and the condition of the subsoil almost invariably change the plans to such an extent that they must be revised or redrawn. All of these conditions should be determined by an exact survey before work on the plans commences.

The first plans to be prepared should be complete machinery plans. A study should be made of the progress of the materials through the shop. In general, the manufacturing processes should be so arranged that there will be no lost motion. The different materials which go to make the finished product should all travel through the various parts of the factory in such a way that they will arrive at the assembling room without having traveled any greater distance and without having been transferred more times than is absolutely necessary. Leaving the assembling room, the materials should go by the shortest possible route to the storage and shipping rooms. This part of the work is, of course, best planned with the prospective superintendent of the shop. The building should be built to suit the machinery. The columns and beams, the height of stories, the location of heating and plumbing pipes, the sprinkler system, and natural and artificial lighting should all be arranged to that one end.

There are two general types of factory buildings. The first is the ordinary one-story building with a hip roof which may or may not be surmounted by a monitor. It usually has a large unobstructed floor space to provide for the movement of cranes and other large machinery. The second type is the warehouse type of one or more stories in height. Industries which require a clear floor space of more than twenty-five feet in either direction are usually housed in one-story buildings because it is expensive to carry the weight of upper floors on long spans. Where the materials manufactured are of such size that columns spaced from sixteen to twenty-five feet on centers are not objectionable, the building of several stories is usually found to be more economical.

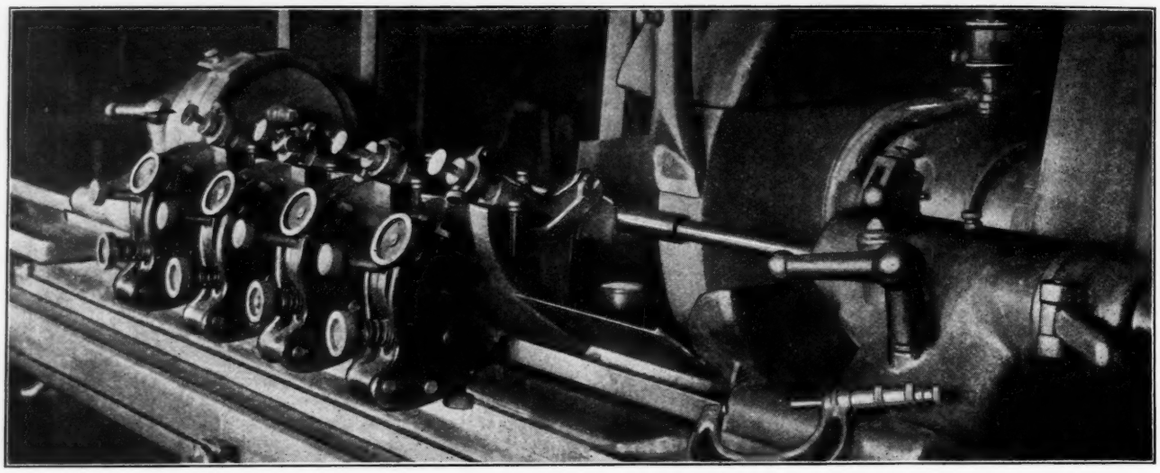
A one-story building costs the most per square foot of floor area. This cost per square foot of floor area decreases somewhat with the number of floors built, up to four stories. Above that height the cost per square foot gradually increases. There is comparatively little difference in the cost per square foot of floor area between a three- and an eight-story building.

If basement floor space is suitable, it is the cheapest which can be obtained, except where the loads to be carried on the first floor are extremely heavy. A one-story shop building in fire-proof construction will cost from $1.25 to $2 per square foot of floor space area, depending upon the height of the story, depth of footings, length of spans and kind of exterior finish used. Fire-proof buildings of more than one story may be built for as little as fifty cents per square foot of floor area. These approximate figures do not contemplate any sort of plaster or interior finish except whitewash. They do include a properly finished cement floor. The cost per square foot decreases as the size of the ground plan increases. It is more for a long, narrow building than for a square building. However, a factory building should not be made too wide on account of the difficulty in properly lighting the interior. For ordinary factory work from forty feet to fifty feet is the best width. A building of this width can be lighted with a story height of from twelve to fourteen feet. If the width of the building be made from seventy-five feet to one hundred feet, then the story height should be increased to from fourteen feet to sixteen feet, the windows being placed as high as possible.

The most common type of roof is the A-shaped roof. This roof has many advantages. It is easy to keep water-tight, it clears itself of snow easily, and with monitors or ventilators at the peak provides good ventilation for the factory. A better type of roof, where light is essential, is the sawtooth roof. This roof is made up of a series of pitched roofs, rising toward the north and stepping down with a vertical step, in which windows are installed. These windows, facing toward the north, admit a diffused light which illuminates the floor below without casting shadows. If the windows in the sawtooth construction are arranged to swing, they provide as good ventilation as the old monitor type.

The most unsatisfactory problem in shop building is probably the roof. It first must be water-tight; second, if the building is to be heated in winter it must be of such material that condensation will not occur on the under side; third, it should be fire-proof; fourth, it must compete with a large number of cheap roofs which are lacking in one or all of these qualifications. A standard roof construction consists of three-inch hollow book tile, laid on steel tees. This

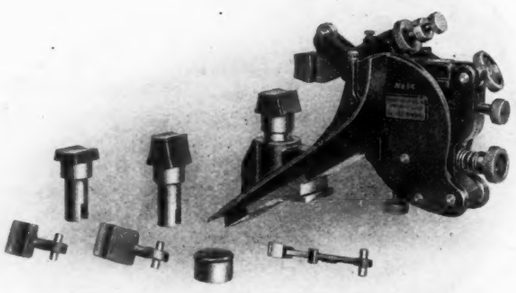
* From a paper by W. E. King, published in the "Journal of the Association of Engineering Societies."



There are Three Distinct Ways in Which Our New Combination Plain and Universal Back Rests Can be Used

OUR new Combination Plain and Universal Back Rest can be adjusted as a plain, semi-universal or universal rest. It has all the well-known features of our Universal Back Rests, is capable of the same delicate adjustments, and has the same efficient means of automatically maintaining an even support against a piece until it is ground to size. It is particularly useful in this respect when grinding long, slender work.

On larger work requiring a little stiffer support, a solid shoe may be inserted under the work and a spring actuated support used behind the work. On very heavy pieces it may be used as a plain back rest with solid support under and behind the piece.



All changes for these various adjustments can be made without taking the rest off the machine, each change requiring but a few seconds. With these rests you have the correct support for any diameter of work within the capacity of the machine. They help you get better results from your heavy grinding machines.

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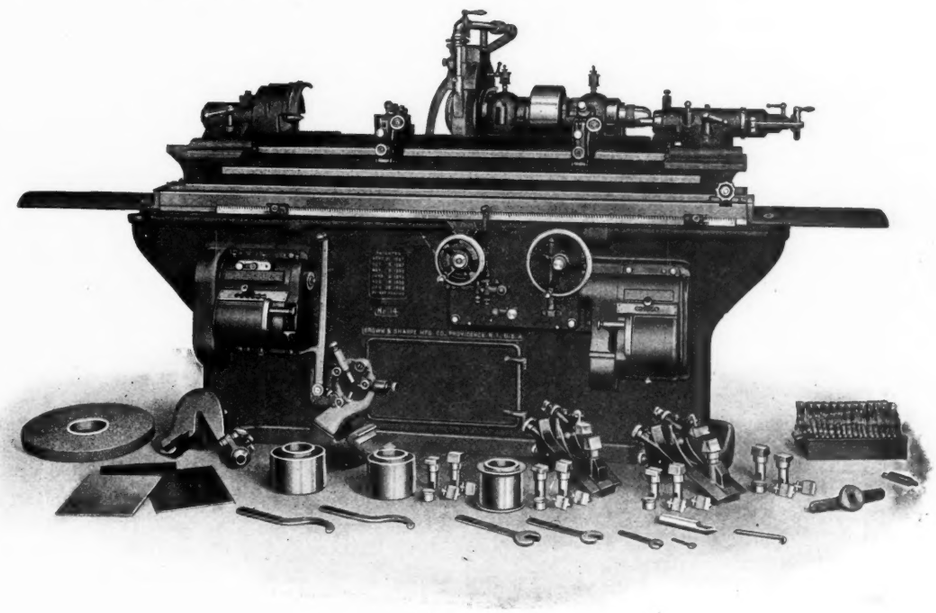
REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland. O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

SPEAKING OF RESULTS, there are a number of other features on our grinding machines that are well worth attention. Speed and feed changes, for instance. Are you familiar with our new quick way of getting these? Look at the cut below. Note those quick speed and feed change mechanisms in the front of the machine either side of the operator's position. Through these an operator is able to get the correct combination of speed and feed for each job and get it *quickly*.

That is why it takes so little time to set up a

B. & S. No. 14 Plain Grinding Machine

And then there is the Automatic Cross Feed that is so handy and dependable. It can be set to reduce pieces to a pre-determined size and then automatically disengage. No attention is required after setting. This is important when grinding a lot of duplicate pieces. There is no uncertainty about results and the operator can prepare work or run another machine while a piece is being ground.



It will be to your advantage to investigate the possibility of one of these machines. Send for a descriptive circular.

FREE—Our Booklet on Grinding Wheels

Do you know how to select the right wheel for each grinding job you do? Here's a handy 50-page book that an alert grinding machine foreman or operator can use. Just drop us a postal for our "Points About Grinding Wheels and Their Selection."

PROVIDENCE, R. I., U. S. A.

CANADIAN AGENTS: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon.

FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfort, a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, Petrograd, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain. The F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia. F. L. Strong, Manila, P. I.

READ PAGE 75

tile is covered with some good prepared roofing that is cemented and tacked to it. This roof is very expensive, but it fulfills all the requirements stated above. It costs, including supports, about thirty cents per square foot.

In the modern factory building the question of material of the outside walls is not an important feature because from 75 to 100 per cent of the wall area is occupied with windows and doors. The old-style shop building did not, as a rule, admit enough light. Windows should be so arranged that light will reach every point from at least two directions and be of as near the same intensity in both directions as possible.

Another question upon which there is usually some argument is the kind of windows to be used. The three types most in use are the standard wooden sash, the rolled steel sash and the fire underwriters' sash of sheet steel or copper. The underwriters' sash is very little used for shop buildings, because of the expense. It will, however, greatly reduce the insurance rate upon such walls of the building as have a bad fire exposure. Underwriters' sash costs about $1 per square foot, glazed with one-quarter inch wire glass and set in place.

The most satisfactory sash at the present time, for factory work, is the rolled steel sash. This is a comparatively new product, having been on the market only a few years. Where large areas are to be glazed the small size of the steel muntins and mullions permits the maximum amount of light to enter the building. The cost of steel sash set in place and glazed with double strength glass runs from forty cents to forty-five cents per square foot, depending upon conditions. The cheapest sash to use is undoubtedly the double hung wooden sash with which we are all familiar. Its cost is from twenty-five to fifty cents per square foot, in place. It allows of 50 per cent opening for ventilation.

Factory buildings of more than one story naturally divide themselves into four general classes, according to the materials of which they are constructed. These classes are, frame construction, slow-burning timber construction, structural steel and reinforced concrete.

In the frame construction class should be included all buildings having either brick or timber walls, wherein the floors are of wood and the joists narrow and spaced close together. Such buildings are the cheapest that can be built. If such a building is anything more than a temporary structure, the fire hazard, the danger to employes upon the upper floors and the lack of rigidity for supporting machinery are disadvantages which justify a type more in accordance with the rules laid down by the fire underwriters.

In the slow-burning mill building construction as described by the fire underwriters, the walls must be of brick or stone. It differs from the frame construction in that the joists are spaced from three feet to six feet apart and are timbers of considerable size. The floors are matched planking. All stairs and elevator hatchways must be enclosed, with doors at each floor opening. This construction is, of course, somewhat more expensive than the frame construction. Its principal advantage is that it takes an insurance rate about 20 per cent less than the frame construction.

Any timber construction has several advantages over more permanent types such as concrete or steel. Alterations in the buildings, due to changes in processes of manufacture and the installation of new machinery, are much more cheaply and rapidly made. The expense of attaching shafting and machinery to the finished structure is considerably less. Wooden buildings are much more rapidly constructed than either reinforced concrete or structural steel buildings.

A better construction consists of steel columns and beams throughout. The floors may then be made of reinforced concrete or tile. If the columns and beams are covered with fireproof material such as tile or concrete the building may be regarded as the best type of building which modern civilization has produced. It is also the most expensive, costing from 5 per cent to 20 per cent more than a reinforced concrete building. The insurance rate for such a building, as compared with a frame building, is 40 per cent less, without a sprinkler system, the frame building rate being $1.50 per $100, and the steel construction rate $0.90 per $100. With a sprinkler system this rate would be reduced to about $0.36 per $100. In fact, many buildings of this type take a rate of ten cents to twenty cents per $100.

A properly designed concrete building is the very best building which can be put up for many industries. It is entirely fireproof and takes the same rate of insurance as a fireproof steel building. Such buildings are probably the most rigid type which can be constructed. The floor spans of a concrete building may be made economically from sixteen feet to twenty-four feet in length. The exact span for minimum cost depends, of course, upon the expense of the foundations. The more expensive the foundation piers, the longer may be the economical span.

Finally it may be said that in the last analysis the most economical factory building is the one where each worker is given the best conditions for doing his work for the least cost.

* * *

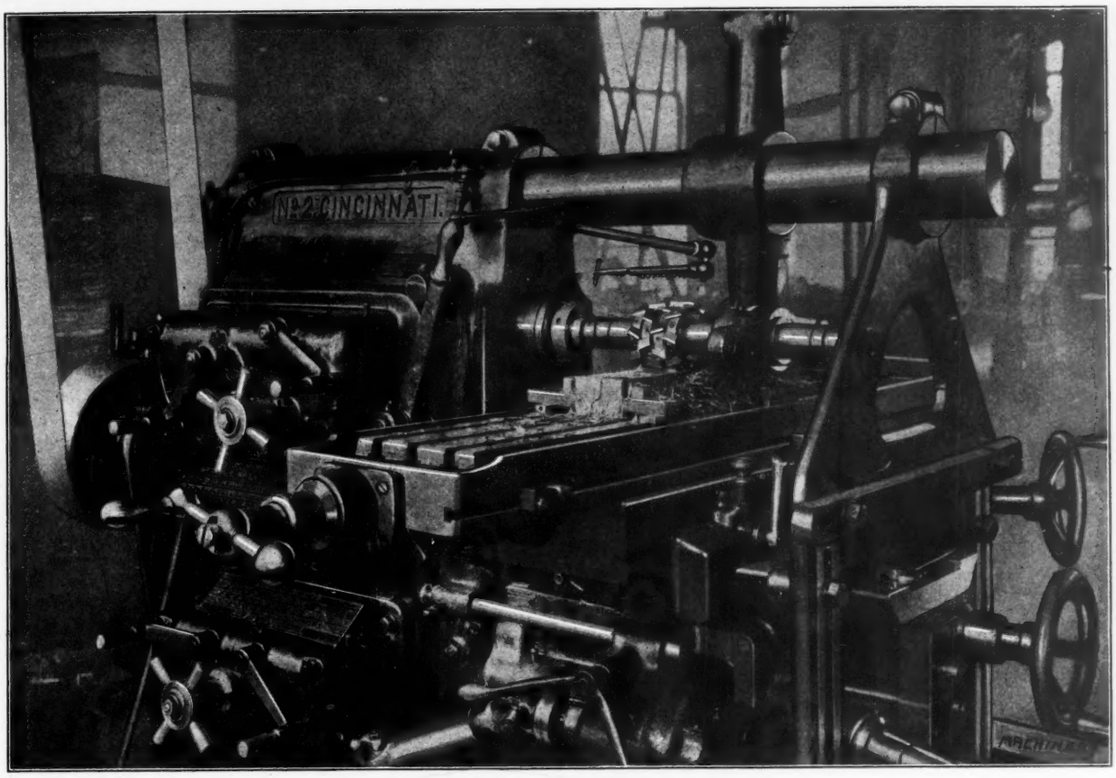
DECARBONIZATION OF STEEL IN SALT BATHS WHEN HEATING FOR HARDENING

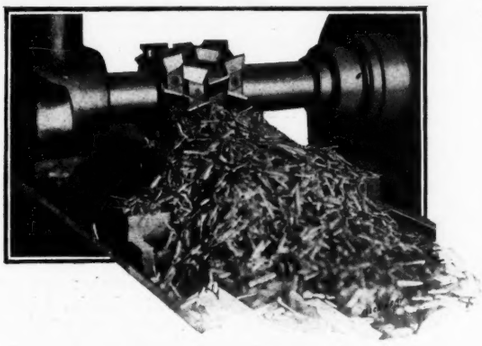
In the April, 1911, number of MACHINERY, an article was published entitled "The Use of Barium Chloride for Heating Steel for Hardening." This article recorded experiments undertaken to show the effect of barium-chloride baths on steel at high temperatures. These experiments were undertaken in connection with regular hardening work, and while they were quite conclusive in character, they did not pretend to investigate the subject on a scientific basis. A French engineer, M. Portevin, of Paris, has made some investigations in the same direction, using more thoroughly scientific methods, and his conclusions agree very closely with those recorded in MACHINERY nearly four years ago.

The use of baths of molten salts, for heating steel prior to hardening is becoming more and more widespread. These salt baths allow of a much more rapid heating and of adjusting the temperatures very accurately. Besides this, superficial oxidation on the objects to be hardened is avoided, but superficial decarbonization occurs instead and becomes strongly marked in cases where the heating is prolonged. In the experiments referred to, the main object was to determine the amount of decarbonization. Samples of steel containing 1.46 per cent of carbon were used in the form of small cylinders about ¾ inch in diameter and ⅜ inch thick. These were heated in potassium chloride for varying periods, at a temperature of 1830 degrees F. Samples were examined after heating, without quenching. It was found that after heating for fifteen minutes in the bath, the percentage of carbon at the surface was 0.9, the thickness of this decarbonized layer being 0.007 inch. After heating for two hours, the carbon content on the surface was only 0.4 per cent, and the thickness of the decarbonized layer 0.040 inch. When one sample was heated for five hours, the carbon on the surface was reduced to 0.2 per cent, the thickness of this layer being 0.060 inch. The steel tested was ordinary carbon tool steel, 1.46 per cent carbon, 0.28 per cent manganese, 0.10 per cent silicon, and 0.025 per cent phosphorus.

Another sample was heated to 1380 degrees F. and quenched in water, and then tested by means of a Shore sclerometer. This test indicated the effect of the heating in the salt bath on the hardness. After heating for fifteen minutes, at 1380 degrees F., the Shore scleroscope indicated a hardness of 80; after two hours heating, a hardness of 41; and after five hours, a hardness of 32. This is, of course, the hardness of the surface. If the decarbonized surface were removed, full hardness would be revealed.

Experiments were also undertaken with baths of potassium chloride at 1650 degrees F., and in a bath consisting of 90 per cent of potassium chloride and 10 per cent of ferro-cyanide. In every case, the results were similar; that is, the carbon content on the surface was considerably reduced and the thickness of the decarbonized layer was increased with an increase in the time the object was submerged in the bath. The conclusions to be drawn, therefore, are that salt baths should not be used for heating tools to be hardened, except in cases where a sufficient portion of the surface of the tool can be ground off, so that the decarbonized layer may be removed.





Such Chips As These Are Valuable

As an indication of the power of the machine making them

The Cincinnati No. 2 Plain High Power Milling Machine

takes this cut in steel 3½" wide, ⅛" deep at 12½" feed. This is not the limit of the machine, but merely an example of good commercial milling.

In "CINCINNATI" High Power Millers are combined the advantages of unsurpassed milling capacity and accuracy of production.

"COLD CHIPS" gives details not in regular catalog. Shall we send you a copy?

The Cincinnati Milling Machine Co.

CINCINNATI, OHIO, U. S. A.

INSUFFICIENT POSTAGE ON AMERICAN MAIL FOR FOREIGN COUNTRIES

Of the mail arriving from the United States to the Consular office at Iquique, Chile, during a period of five consecutive days from American firms, 40 per cent was prepaid with two cent stamps only, instead of the required five cents. In one of the business houses in Chile, the head of the firm goes to the post office and looks over the short-paid letters to his address and pays penalty only on letters from those persons with whom his firm is in correspondence. On mail from other sources the penalty postage is not paid, and hence not received by the firm to whom it is sent. The administrator of the post office states, according to a consular report, that few if any letters with short-paid postage are received from Europe, but that a large number come from the United States and that these rarely reach the addressees. The firms to whom short-paid letters are sent believe that if such a small matter as postage is overlooked or neglected, it may be expected that negligence will be found in a great many other departments of the firm from whom the letter is received, and that lack of proper attention to invoices, packing and shipping orders may be expected; hence, they refrain from doing business with such firms.

* * *

EXCHANGE BETWEEN RUSSIA AND THE UNITED STATES

In a consular report from Petrograd, it is stated that the commercial relations between Russia and the United States will, without doubt, be much closer in the near future, providing the financial questions involved are adjusted. There is no settled rate of exchange between Russia and the United States and only a small amount of Russian money is available in the United States for payment on orders. It is suggested that it is necessary for an arrangement to be made with American bankers or manufacturers whereby purchasers in Russia may deposit Russian money in a bank there to the credit of American bankers, and then that the bank there may cable directly that the required sum has been deposited. American bankers and manufacturers could then obtain the money from Russia as soon as a rate of exchange has been established. The Russian and English Bank in Petrograd offers to pay three per cent interest on deposits of this kind at the present time. No money panic has occurred in Russia and the gold, silver and paper rubles have not fluctuated in value since the declaration of war. Prices should be quoted in rubles and not in dollars.

* * *

PERSONALS

John A. Schroeder, formerly general sales manager of the Hyatt Roller Bearing Co., has resigned his position.

W. S. Chase, general sales manager of the National-Acme Mfg. Co., Cleveland, Ohio, sailed October 27 for London on a business trip.

W. S. Rogers, president of the Bantam Anti-Friction Co., Bantam, Conn., was elected representative to the state legislature at the recent election.

A. J. Strong, factory and sales manager of the Bock Bearing Co., Toledo, Ohio, has resigned his position. Mr. Strong has not as yet joined any other organization.

B. Elshoff recently resigned his position as superintendent of the electrical department of the Canadian Westinghouse Co., Ltd., to become works manager of the Diehl Mfg. Co., Elizabeth, N. J.

Charles L. Samson has resigned the position of mechanical engineer with the Griffin Wheel Co., Chicago, Ill., and has taken the position of master mechanic of the Hamilton Mfg. Co., Two Rivers, Mich.

Edwin Frank, formerly in the hydraulic department of the Allis-Chalmers Mfg. Co., West Allis, Wis., has been appointed instructor in mechanical engineering at the University of Illinois, Urbana, Ill.

Ellsworth Haring has terminated sixteen years' service with Hermann Boker & Co., New York City, and has organized a business in the tool steel and specialty line, with temporary offices at 648-A Hancock St., Brooklyn, N. Y.

F. E. Liddle has resigned his position as superintendent of the American Gear & Mfg. Co., Jackson, Mich., on account of ill health. C. S. Spencer, formerly assistant superintendent of the American Gear & Mfg. Co., has been promoted to the position of superintendent.

William J. Dyer has resigned his position with the Honolulu Iron Co., Honolulu, Hawaii, as designing and constructing superintendent of machinery for the cane sugar industry, and has opened an office as consulting engineer in the Stangenwald Bldg., Honolulu, Hawaii.

Joseph Schaeffer, European representative of the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., arrived in New York, October 31 on the steamer *New Amsterdam*, sailing from Holland. Mr. Schaeffer does not expect to return to Holland until the war is over.

Arthur H. Lymn of London, England, inventor of the Lymn process, presented a paper at the monthly meeting of the American Society of Mechanical Engineers, New York City, November 10, entitled: "The Development of the By-Product Gas Producer Industry in Europe."

W. C. Buell, Jr., for the past seven years general manager and engineer for the Westmacott Gas Furnace Co., Providence, R. I., has resigned and taken the position of assistant manager and engineer of the Bellevue Furnace Co., Detroit, Mich., manufacturer of oil and gas furnaces, kilns, special fire brick, tiling, etc.

H. H. Hodell has been elected president of the Van Dorn & Dutton Co., Cleveland, Ohio, to fill the vacancy caused by the death of James H. Van Dorn. Mr. Hodell is president of the Cleveland Galvanizing Works Co., and was one of the founders and a vice-president of the Van Dorn & Dutton Co. D. B. Van Dorn, president of the Van Dorn Iron Works Co., was elected vice-president to succeed Mr. Hodell.

James Cran, a well-known contributor of articles on blacksmithing, heat-treatment of steel, etc., has resigned his position as foreman blacksmith with the Pond Machine Tool Works, Plainfield, N. J., and will hereafter devote himself to artistic blacksmithing, difficult repair work, etc. Mr. Cran has achieved considerable prominence as a producer of artistic iron work, ornamental table pieces and other interesting and difficult examples of forging.

Arthur E. Meyer, for the past five years connected with the sales department of the Toledo Machine Tool Co., Toledo, Ohio, has resigned his position and has become connected with the sales department of the E. W. Bliss Co.'s Chicago branch. The Chicago branch territory has been extended from a hundred mile radius to include the states of Wisconsin, Indiana, Illinois, Minnesota, Iowa, Kansas and Missouri. Mr. Meyer is the author of a number of articles on press design which appeared in MACHINERY a few years ago.

* * *

OBITUARIES

Louis A. Lincoln, president and treasurer of the Bay State Tap & Die Co., Mansfield, Mass., died November 5, aged forty-three years. Mr. Lincoln was the chief organizer of the company, its first place of business being in Taunton, Mass. In 1903 it was moved to Mansfield, where it has since been located. Mr. Lincoln was the first president, and afterward became president and treasurer.

Henry H. Boggs, vice-president and general manager of Strong, Carlisle & Hammond Co., Detroit, Mich., died November 1, following an operation for gall-stones, aged forty-seven years. Mr. Boggs was born in Springfield, Ohio, and was educated in the public schools. He began his career as a machinists' apprentice in 1883 with the St. John Sewing Machine Co. of Springfield, continuing with the company for four years; following his apprenticeship, he worked for the William Whiteley Co. of Springfield for two years and with the Machinists' Supply Co. of Chicago for four years. He entered the employ of the Strong, Carlisle & Hammond Co. of Cleveland in 1897, and when in 1908 the Strong, Carlisle & Hammond Co. of Detroit was incorporated, Mr. Boggs became vice-president and general manager. He was a Mason and a member of several Detroit societies and clubs. Those associated with Mr. Boggs in business feel that they have lost a generous friend, and the many who knew him in a business way will learn of his death with regret, as his council regarding mechanical matters was held in high esteem. He was married in 1896 to Anna L. Barker of Springfield.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC.

of MACHINERY, published monthly at New York City, required by the Act of August 24, 1912.

Editor, Fred E. Rogers 140-148 Lafayette St., New York
Business } Alexander Luchars, President " " " " "
Managers } M. J. O'Neill, General Manager " " " " "
Publisher, The Industrial Press " " " " "
Owners of one per cent or more of the stock:—
Alexander Luchars " " " " "
Matthew J. O'Neill " " " " "
Fred E. Rogers " " " " "
Louis Pelletier " " " " "
H. L. Brown " " " " "
Erik Oberg " " " " "

There are no bondholders, mortgagees, or other security holders.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 30th day of September, 1914.

HARRY B. HEALEY,
Notary Public No. 84, Kings County,
Certificate filed in New York County No. 74.
(SEAL) (My commission expires March 30, 1916.)

A COMPLETE LINE OF COMPLETE MACHINES

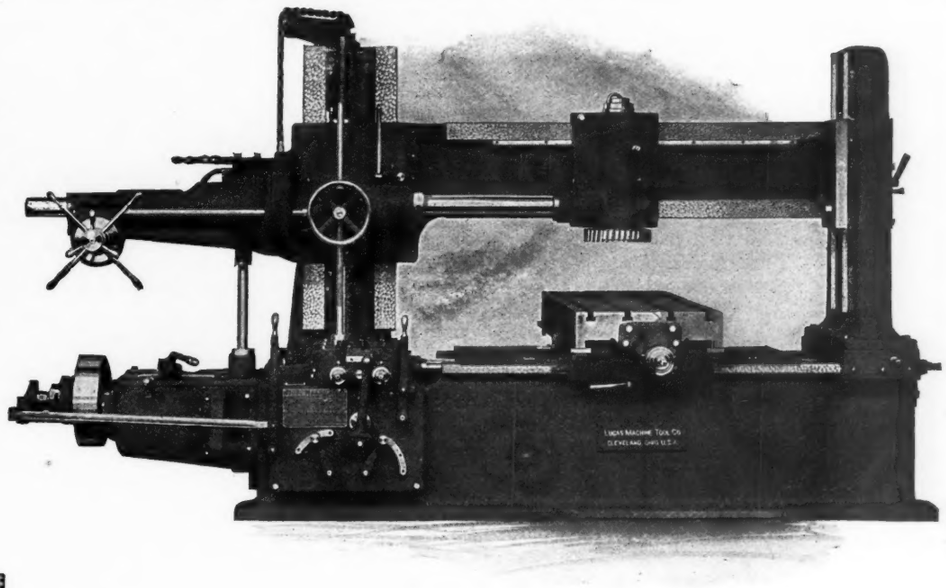
3 SIZES OF THE "PRECISION" BORING, DRILLING AND MILLING MACHINE

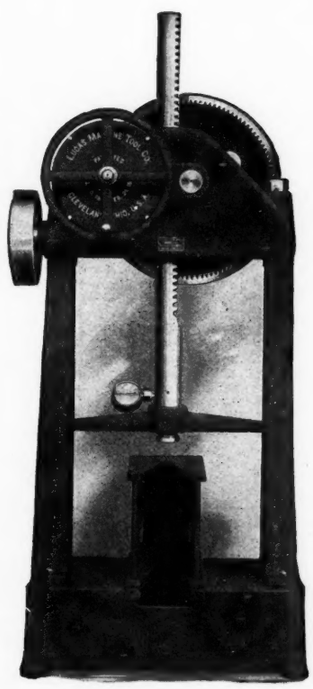
(ALL OF THE SAME GENERAL DESIGN)

With or Without

Vertical Milling Attachment

We Can Serve You Well





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For instance, in pushing anything OUT, the power action of the Press CEASES as soon as the thing is out; therefore, the Press does not (and cannot) "race."

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COMING EVENTS

December 1-4.—Annual meeting of the American Society of Mechanical Engineers, New York City; Engineering Societies Bldg., 29 W. 39th St., headquarters. Calvin W. Rice, secretary.

December 9-12.—Eighth annual convention of the National Society for the Promotion of Industrial Education, Richmond, Va. C. A. Prosser, secretary. 140 W. 42nd St., New York City.

December 12-19.—Second International Exposition of Safety and Sanitation, Grand Central Palace, New York City. F. W. Payne, manager, Department of Exhibits, 29 W. 39th St., New York City.

June 9-11.—Annual convention of the American Railway Master Mechanics Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-16.—Master Car Builders' annual convention, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

SOCIETIES, SCHOOLS AND COLLEGES

Pratt Institute, Ryerson St., Brooklyn, N. Y. Circular calling attention to its free library which is placed at the disposal of every visitor under the guidance of a special librarian. It comprises a working library of over 1200 picked books, 150 technical periodicals, patent office reports, trade catalogues, etc.

State Trade Education Shop, Bridgeport, Conn. Bulletin 1914 containing an outline of the work of the institution and its purpose, a review of the trades taught, and showing some of the work accomplished by the student apprentices. This book was designed and printed in the State Trade Shop by the printing apprentices and is a creditable production of which they may be justly proud. The various trades taught in this school are: carpentry, cabinet work, patternmaking, machine work and toolmaking, drafting, printing, linotype operating, sewing, dressmaking, millinery, etc.

West Side Young Men's Christian Association, 318 W. 57th St., New York City, has organized a course of lectures on exporting and importing which was opened early in November. The director of the course is Dr. John Franklin Crowell, former president at Trinity College, Durham, N. C., now of the "Wall Street Journal." Among the subjects to be taken up are choice of markets, how to organize exporting campaigns, foreign exchange, peculiarities of conditions and people of different countries, packing methods and shipping arrangements, trade routes and international connections, the problem of credits, correspondence and trade literature, and social, economic and political aspects of business in foreign countries.

NEW BOOKS AND PAMPHLETS

Safety and Welfare of the Workman. By Rear Admiral A. B. Willits. 12 pages, 6 by 9 inches. Reprinted from the U. S. Naval Institute Proceedings, Annapolis, Md.

Standard Methods of Gas Testing. 180 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 48.

Units of Weight and Measure—Definitions and Tables of Equivalents. 68 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 47.

Analysis of Printing Inks. By J. B. Tuttle and W. H. Smith. 20 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 39.

The Veritas Firing Rings. By A. V. Bleininger and G. H. Brown. 10 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 40.

Measurements on Standards of Radiation in Absolute Value. By W. W. Coblentz. 14 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 227.

Industrial Gas Calorimetry. By C. W. Waldner and E. F. Mueller. 150 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic paper of the Bureau of Standards No. 36.

The Testing of Potentiometers. By Frank Wenner and Ernest Weibel. 40 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 223.

Safety Rules to be Observed in the Operation and Maintenance of Electrical Equipment and Lines. 50 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No: 49.

Observations on Finishing Temperatures and Properties of Rails. By G. K. Burgess, J. J. Crowe, H. S. Rawdon and R. G. Waltenberg. 67 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 38.

Adjustments of the Thomson Bridge in the Measurement of Very Low Resistances. By F. Wenner and E. Weibel. 68 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 225.

Sheet Metal Working. By F. Georgi and A. Schubert. 160 pages, 5½ by 8¾ inches. 125 illustrations and two folding plates. Published by Scott, Greenwood & Son, London; and D. Van Nostrand Co., New York City. Price, $3, instead of $2 as stated in the November number.

Gearing. By A. E. Ingham. 181 pages, 6 by 9 inches. Illustrated. Published by D. Van Nostrand Co., New York City. Price, $2.50.

This work by a British author deals with spur and bevel gears, worm-gearing, spiral gears, helical gears and contains an appendix of trigonometrical tables. Tables of tooth parts accompany the text, and silhouettes of involute gear teeth ranging from 11 diametral pitch to 3 inches pitch. A table of pitch line and outside diameters for cut gear circular pitches is given, ranging from ¼ inch circular pitch to 4 inches. Another table is pitch angles for bevel gears with axes at right angles; tables of increment and decrement angles are also given.

Materials of Machines. By Albert W. Smith. 215 pages, 4¾ by 7⅝ inches. 36 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $1.25.

This work, by Prof. Smith of Sibley College, Cornell University, has been rewritten for the second edition. Its object is to supply elementary knowledge of metallic materials used in the construction and operation of machines, and it was intended primarily as a textbook for students in the mechanical engineering courses. It deals with fuels; electric furnaces; refractory materials; metallurgy of iron and steel, copper, lead, tin, zinc and aluminum; testing of materials; relation of iron and carbon; cast iron; steel; heat-treatment of steel; non-ferrous alloys; and the selection of materials for machines.

Electric Welding. 48 pages, 6 by 9 inches. 22 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This is No. 127 of MACHINERY's Reference Books, covering a subject of general interest to mechanical men. Although the electric welding process passed out of the experimental and into the practical stage several years ago, the subject is still one that is rather vague to most mechanics. Electric welding, however, plays an important part in the manufacture of so many articles, and the possibilities opened up by the process of electric welding are so great, that mechanical men generally are eager to be informed upon this new topic. The book reviews the various electric welding processes that have been developed, and then deals in detail with the electric resistance process of welding, also known as the Thomson process or the incandescent process; the point and ridge method of electric welding—an application of the Thomson process; electric arc welding; and electric soldering.

Mechanism of Steam Engines. By Walter H. James and Myron W. Dole. 170 pages, 6 by 9 inches. 183 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $2.

This work, by Profs. James and Dole of the Massachusetts Institute of Technology, was prepared as an elementary treatise on kinematics of reciprocating steam engines and steam turbines, and was intended primarily for students in the mechanical engineering courses. No claim is made for originality of treatment or for discussion of new principles. The aim has been to handle the subject in a manner suitable for the purpose intended. The work deals with reciprocating steam engines, single-valve engines, valve diagrams, typical problems on the slide-valve engine, governing devices for single-valve engines, riding cut-off valves and their governing devices, multiple-valve engines, hand-operated reversing and controlling gears, valve setting, steam turbines and turbine valve mechanisms and governors.

Shop Systems. 39 pages, 6 by 9 inches. 32 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This is No. 139 of MACHINERY's Reference Books, covering four typical shop systems used in representative machine-building plants. The systems described are: a general shop system; a stock-keeping system; an effective follow-up system; and a routing system in a machine tool shop. The systems outlined in this book have proved of value in the manufacturing establishments where they are used. They may not apply directly to the conditions in other plants, because certain details may have to be changed and some of the forms modified, on account of the conditions that are peculiar to each shop; but there are certain fundamental principles that must be embodied in all shop systems, and the general outlines of the systems described can be followed and will prove of value to those who have to devise new systems or are endeavoring to improve upon old ones.

Autogenous Welding. 40 pages, 6 by 9 inches. 22 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

During the last fifteen years, several interesting and valuable processes for joining metal parts have been developed. Of these, perhaps none is more remarkable than the oxy-acetylene and the oxy-hydrogen processes for welding and cutting metals. There are no inexpensive treatises on this subject on the market, and the book under review has, therefore, been brought out to give mechanical men such practical information about the processes as will be helpful to them in their work and aid them in understanding the possibilities of the use of the autogenous welding processes. The book contains chapters on the oxy-acetylene and oxy-hydrogen processes of metal cutting, on autogenous welding, and on the preheating of metals to be welded. In addition, there are special chapters dealing with the welding of tanks and retorts, the repairing of cylinders by autogenous welding and the manufacture of tubing by this means.

Precision Locating and Dividing Methods. 45 pages, 6 by 9 inches. 39 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This treatise, which is No. 135 of MACHINERY's Reference Books, covers a subject of great interest to toolmakers and others who are engaged in accurate work. In this book various approved methods of locating work and accurate dividing and spacing methods, such as are used more particularly in tool-rooms, are illustrated and described. In the three chapters on precision locating methods, accurate dividing and spacing methods and locating work for boring on the milling machine, the button method for locating holes is taken up in detail, the disk method is illustrated and described, and the method of obtaining accurate angular measurements with disks is covered, as is also the size block method and the master plate method. A great number of accurate dividing and spacing methods are illustrated and described, both for spacing along straight and circular lines. The book can be recommended to all who are engaged in accurate machine work.

Care and Repair of Gas and Oil Engines. 48 pages, 6 by 9 inches. 14 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This treatise, which is No. 129 of MACHINERY's Reference Books, has been prepared mainly from notes compiled by J. L. Hobbs, who has had long and varied experience with the care and repair of gas and oil engines. The book is written in a thoroughly practical manner and covers the usual difficulties met with in the operation of gas and oil engines. A general description of internal combustion engines is given, and then follow chapters on compression, carburetion, ignition, lubrication and cooling systems. In each case, the troubles that are likely to develop are dealt with and remedies given. A chapter is also included on the installation of a gas engine, giving valuable information on the points to be taken into account. Several full page illustrations showing sectional views of various types of gas and oil engines are included. The book should prove of value to anybody who has to do with the care or repair of gas and oil engines.

Broaching. 40 pages, 6 by 9 inches. 36 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

The cutting of keyways and the machining of holes in metal to shapes other than round, by broaching, is an old practice, although it has attracted comparatively little attention until within the past ten years. Now the broaching process is used very extensively and there is need for a treatise dealing with the broaching machine, broach making and broaching operations. Comparatively little has been published on this subject in the trade periodicals, and nothing whatever has been presented in book form previous to the publication of the book under review. It was therefore deemed that a specific service would be rendered the mechanical trades by preparing such a treatise, and the present book is the result of the collaboration of Franklin D. Jones, Douglas T. Hamilton and Chester L. Lucas, associate editors of MACHINERY, who here present a comprehensive and valuable collection of material relating to this important subject.

Cutting Lubricants. 36 pages, 6 by 9 inches. 31 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

The cutting lubricants to be used for machining operations constitute a very important factor in the results obtained in the machine shop. The book under review, which is MACHINERY's Reference Book No. 124, contains information relating to the various lubricants, oils and compounds to be used for different classes of machining operations and for different kinds of metals. It also gives a comprehensive review of the pumps, piping systems, oil pans and tanks used for storing the cutting lubricant for machine tools and for conveying the lubricant to the cutting point of the tools. Numerous illustrations showing clearly by line engravings the exact construction of the devices described are included. The book should, therefore, prove of value both to the operators of machine tools, in aiding them to select the proper cutting lubricant to use, and to the designers of machinery or attachments who have to devise ways and means by which the cutting lubricant is to be conducted to the cutting point.

Drawing, Forming and Bending Dies. 40 pages, 6 by 9 inches. 41 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

Comparatively little information has been published in book form relating to the subject of drawing dies. A large majority of work which, in the past, has been made from castings is now made from sheet steel by drawing up bosses and reinforcing ribs to strengthen the work. The development in the art has been rapid and the definite information available on the subject relating to the diameters of shell blanks, the depth and diameter reductions of drawn shells, the lubrication of dies and other practical points are given in this book, which is No. 126 of MACHINERY's Reference Books. A number of practical hints for die-makers in the making of forming dies are also given and, in addition, numerous examples of successful designs of drawing, forming and bending dies. The book thus gives the reader a comprehensive review of the present state and methods of the art. Toolmakers, tool-designers and those responsible for the output of punches and dies will be especially interested in this book.

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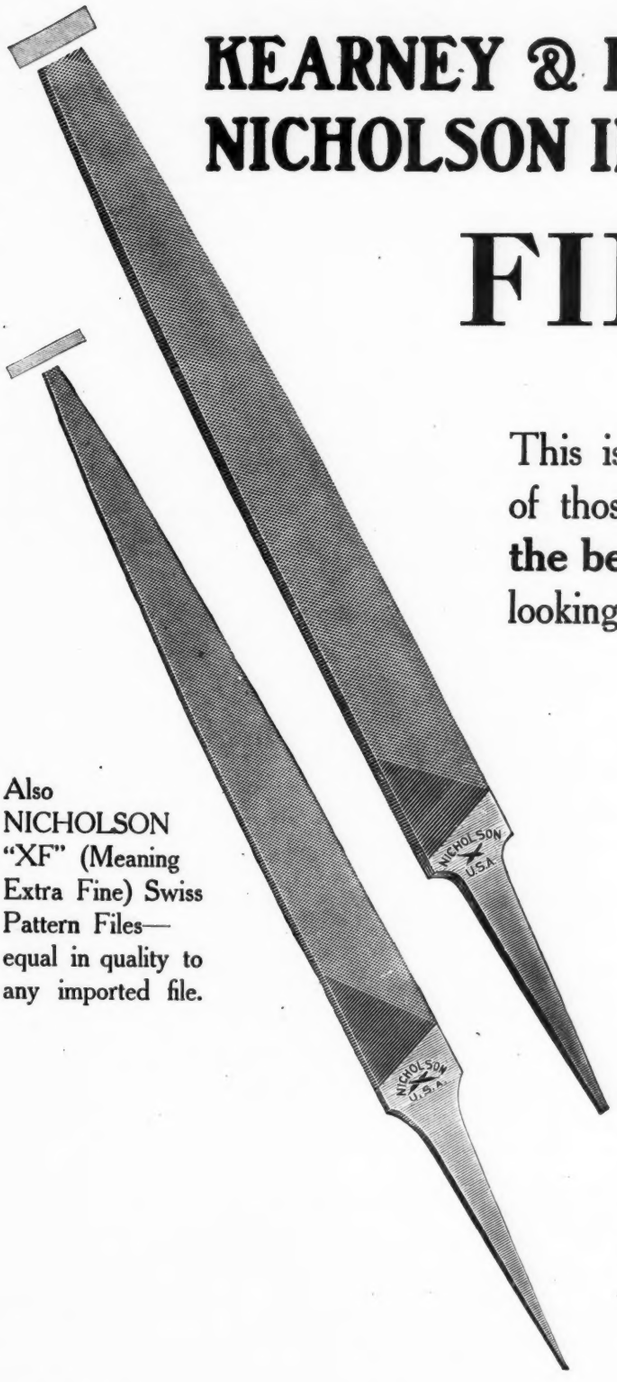

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HARDWARE, TOOLS AND SUPPLIES

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Power, Heating and Ventilation. Parts I and II. By Charles L. Hubbard. 299 pages, 6 by 9 inches. 183 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $2.50 each.

This work is issued in three parts, namely: Steam Power Plants, Heating and Ventilating Plants, Isolated Plants and Small Groups. The third part is in press. Part I treats of heat; steam; fuels and combustion; boiler horsepower; types of boilers; design of tubular boilers; boiler furnaces; boiler settings; chimneys; mechanical draft; boiler accessories; steam engines and turbines; auxiliary apparatus; pipe, fittings and valves; details of power plant design; and care and management of boilers and engines. Part II treats of the physics of heating and ventilation; heat loss from buildings; ventilation; furnace heating; boilers; pipe, fittings and valves; direct steam heating; indirect steam heating; hot water heating by gravity circulation; hot water heating by forced circulation; exhaust steam heating; electric heating, fans; forced blast heating and ventilation; special devices; heating and ventilating different types of buildings; care and management of heating and ventilating plants. Both parts are of the second edition and have been revised and reset, bringing them up to date and eliminating obsolete material.

Strength of Materials. By Erik Oberg. 47 pages, 6 by 9 inches. Published by the Industrial Press, New York City. Price, 25 cents.

This book covers in a simple and direct manner the principles of the strength of materials and the methods used in calculating the strength of parts met with in machine design and engineering work generally. The formulas are given in the simplest manner possible, so that they can be directly employed by the practical man. No attempt has been made to show how the formulas are derived mathematically, as this would be impossible in a book of limited size. Numerous examples have been given to show the application of the rules and formulas to specific problems. A special effort has been made to indicate the use of standard engineering handbooks in connection with the calculations of strength of materials, and numerous references are made to tables and formulas found in works of that kind. The five chapters of the book cover principles of the strength of materials; tension, compression and shearing stresses; beams and bending stresses, torsional stresses and applications; shafting; springs; columns; flat plates; cylinders cylinders and tubes; and spherical shells.

Arithmetic Simplified. By Erik Oberg. 48 pages, 6 by 9 inches. Published by the Industrial Press, New York City. Price, 25 cents.

During the past seven years MACHINERY has published a series of over 140 25-cent Reference Books, many of which are of an educational nature and intended for home study. These books necessarily contain mathematical treatment of various shop problems, and it has been found that in some cases mechanics have not been able to get the full benefit because their knowledge of arithmetic, especially of fractions, has been too limited. The present work, which is No. 137 of MACHINERY's Reference Books, and which covers in a very simple manner the arithmetic of whole numbers, common fractions and decimals, has, therefore, been brought out to meet the needs of men whose early training on these subjects may not have been as complete as desirable, or who would like a book on arithmetic to refresh their memory. In addition to the treatment of whole numbers, fractions and decimals, a chapter on proportion and on the use of formulas in ordinary arithmetical work is included. The method by which the whole subject is presented is such as to particularly adapt this book to the student who has no teacher, but it is also well suited for use in apprentice and trade schools, as it covers the essentials only. The apprentice and trade schools usually can devote but little time to this subject, and the larger text-books, including much extraneous matter, are, therefore, not so well adapted for use in this class of schools.

Planing and Milling. By Franklin D. Jones. 306 pages, 6 by 9 inches. 234 illustrations. Published by the Industrial Press, New York City. Price, $2.50.

This book deals with the practical problems met with in the operation of planers, shapers, slotters and milling machines of standard and special designs. Each of the subjects taken up is treated from the standpoint of the man in the shop, and a special effort has been made to present such information as pertains more particularly to problems which the shop man often finds difficult to solve. The examples of operation included have been selected with a view to showing not only how a specific result is obtained, but to illustrate fundamental principles and thus serve as a general guide. Descriptions of methods involving arithmetical calculations contain the necessary rules or formulas, and examples are given illustrating the problems which arise in practice. The illustrations in the book constitute an important feature and have received particular attention. Practically all of the drawings are original and most of them are of simple type, so that they can be easily understood, even by those who are not accustomed to "reading drawings." In preparing the book, the author has made use of much of the material published in MACHINERY's Reference Books Nos. 93, 96 and 97, which material appears in this book together with a great deal of additional information on modern planing and milling practice. The book is one which can be thoroughly recommended to anyone who wishes to make a study of the most modern methods relating to planer, shaper, slotter and milling machine work and the types of machines used.

Machine Drawing. By Charles L. Griffin and C. C. Adams. 271 pages, 5½ by 8¼ inches. Illustrated. Published by the American Technical Society, Chicago, Ill. Price, $1.50.

This work is a revision and an extension of an earlier work by Mr. Griffin which attracted much attention at the time of publication because of its practical, common-sense treatment of the subject. The revised and extended work is, of course, better than the original, as it contains more matter and has been brought up to date. It defines a working drawing as "a drawing which completely instructs the workman so that he is able actually to make in the shop whatever the drawing represents." In other words, the working drawing conveys to the mechanic all the information necessary to make the object. This is a comprehensive definition, and any work on drawing which instructs its readers to make drawings truly complete in every respect deserves general attention. The contents comprise the following: Lines, Arrangement of Views, Sectional Views, Shade Lines, Dimensions, Specifications for Screw Threads, Specifications for Bolts and Nuts, Specifications for Pipes and Pipe Threads, Scale Drawings, Details of Preparation, Pencil Drawing, Tracing, Blueprinting, Illustrative Drawings (with large number of parts); Working Drawings; Mechanism Drawing; Duplex Pump Plates; Electrical Shop Drawings; Design of Direct-current Generator (in all its details, including a final assembly drawing). The work is one that can be recommended to all wanting a first-class work on mechanical drawing with many good examples for practice.

Graphic Methods for Presenting Facts. By Willard C. Brinton. 371 pages, 7 by 10 inches. 255 illustrations. Published by the Engineering Magazine Co., New York City. Price, $4.

The graphical method of presenting data and making comparisons of same is too well known among the engineering fraternity to need any explanation. But notwithstanding the conceded value of this method of presenting facts, not only to the engineer but to the layman as well, it has not been employed as much as it could have been with profit to all concerned. The work by Mr. Brinton has been presented to suit the point of view of the business man, the social worker and the legislator, and mathematics have been eliminated. The effort has been made to produce a work that would serve as a handbook for anyone having occasional charts from data presented to them in tabulated figures. The work is too extensive for us to give more of a general idea of its contents than by quoting chapter heads, which are as follows: Component Parts; Simple Comparisons; Simple Comparisons Involving Time; Time Charts; Curve Plotting; Curve Plotting Continued; Comparison of Curves; Component Parts Shown by Curves; Cumulative or Mass Curves; Frequency Curves; Correlation; Map Presentations; Maps and Pins; Curves for the Executive; Records for the Executive; Corporation Financial Reports; General Methods; A Few Cautions. The 7- by 10-inch page favors the presentation of comparatively large diagrams to illustrate the examples chosen. The many examples, and the clear presentation of the subject matter make a work that can be recommended to general managers, superintendents, draftsmen and business men to whom the graphic presentation of facts appeals.

NEW CATALOGUES AND CIRCULARS

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Circular on Cutler-Hammer automatic starters for electric motors.

H. D. Smith & Co., Plantsville, Conn. Leaflet advertising the "Perfect Handle" valve spring lifter for automobile engines.

Richard W. Jefferis Co., Camden, N. J. Folder advertising Jefferis pressed steel fire-proof lockers, wardrobes, bins and shelving.

New York Public Library, New York City. List of works in the library relating to oxy-acetylene welding. 34 pages, 6 by 9 inches.

Huther Bros. Saw Mfg. Co., 1108 University Ave., Rochester, N. Y. Circular descriptive of Huther Bros. "Dado" head for cutting grooves of any width in wood.

Morrison Co., Inc., Richmond, Va. Leaflet giving tables of sizes and prices for plain right-hand pipe nipples, plain right- and left-hand pipe nipples, and galvanized right-hand pipe nipples.

Wright Mfg. Co., Lisbon, Ohio. Catalogue on Wright standard chain hoist, giving sizes, capacities and prices of high-speed steel hoists, screw hoists, steel trolleys and hand traveling cranes.

Standard Mfg. Co., Bridgeport, Conn. Circular of No. 3 special automatic manufacturing milling machine for slabbing, radial, center and straddle milling, and various manufacturing milling operations.

General Electric Co., Schenectady, N. Y. Bulletin 46018, describing portable voltmeter, known as Type P-8. This is an unusually small instrument, suitable for use on both alternating and direct current.

American Blower Co., Detroit, Mich, is issuing a book illustrating the installation of the "Sirocco" heating, ventilating and cooling system in the plant of the Ford Motor Co. at Detroit. This is the largest "Sirocco" system ever installed.

Builders Iron Foundry, Providence, R. I. Bulletin 85 of the "Venturi" hot water meter for boiler feeds, etc. This type of meter is peculiarly adapted for measuring hot water, a service that is extremely hard on meters in general.

General Electric Co., Schenectady, N. Y. Bulletin 44300, illustrating and describing some of the gas-electric motor cars and locomotives built by this company. These cars and locomotives are adapted for branch line service on steam roads and also for interurban service.

Foundry & Machine Exhibition Co., Chicago, Ill. Registration list at the 1914 annual exhibition in the International Amphitheater, Chicago, September 5-11. The announcement is made that the 1915 convention will be held in the East, either at New York, Philadelphia or Atlantic City.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Leaflet 3749 describing Westinghouse synchronous booster rotary converters. This bulletin outlines the advantages of this type of machine and gives a detailed account of its method of operation and construction details.

David Lupton's Sons Co., Allegheny Ave. and Janney St., Philadelphia, Pa. Catalogue 8, listing the line of Lupton products for light and ventilation, which comprise steel sash, steel partition, steel tube doors and jams, continuous sash, trusses, operating devices and skylights.

Agnew Electric Welder Co., Detroit, Mich. Circulars of No. 5-C butt electric welder; No. 10-D spot welder; No 20-D spot welder; and No. 40-C butt welder. The welding capacity of the latter is ⅞ to 2 inches round or 5/16 by 10 inches flat. The transformer capacity is 50 K. W.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1018-A, superseding Bulletin 1018, on E. C. & M. motor field rheostats and field rheostat relays for adjustable speed direct-current motors. Bulletin 1029-A, superseding Bulletin 1029, on Type Q, Form FM brakes for direct-current mill type motors.

Eck Dynamo & Motor Co., Belleville, N. J. Sectional catalogue consisting of bulletins 39, 40, 44, 46, 47 and 55 of protected type direct-connected dynamos, worm-geared motors for slow speeds, back-geared motors, motor generators, and suggestions for installing and operating.

General Electric Co., Schenectady, N. Y., has just issued Bulletins 44403 and 44405, describing that company's ventilated commutating-pole railway motors for 600 and 600-1200 volt service. Bulletin 44403 is devoted to the GE-222-G railway motor, and Bulletin 44405 describes the GE-233-A motor for operating two in series on 1200 volts.

Electric Welder Co. of America, 1523-31 Fort St., W., Detroit, Mich. Circular of type C duplex convertible electric welders which may be used for butt welding and spot welding. The machine is fitted with heat control apparatus, by means of which it is claimed that objects of unequal size may be readily welded by an ordinary operator.

Golden-Anderson Valve Specialty Co., Fulton Bldg., Pittsburg, Pa. Bulletin of double-cushioned, triple-acting, non-return valves that effectually prevent accidents in boilers and steam-pipe lines. These valves automatically shut off the steam flow from every boiler the instant the pipe ruptures, and immediately cut out a boiler when a tube bursts.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Data sheets illustrating ball bearings and their correct use in machinery as follows: vertical mountings on shafts without shoulders; standard mountings for horizontal and ball bearing electric motors; turbine pump; ball bearing live tail centers; and ball bearing lathe head.

Boston Gear Works, Norfolk Downs, Mass. Circular showing Boston gears that are kept in stock for immediate delivery. These gears, being made in large quantities, can be furnished at correspondingly low prices. Circular showing standard racks made to mesh with stock gears. These racks are made in any pitch up to 1 diametral pitch, 12 inches face.

Bridgeport Hardware Mfg. Corp., Bridgeport, Conn. 1914 supplement to catalogue 18, describing the new tools that have been added to the line of hardware and cutlery specialties made by this company. Some of the tools listed are pocket knife tool kit, comprising a file, reamer, cork puller, screw driver and chisel; coping saw; ticket punchers; crate opener; screw-drivers; pliers; scrapers, etc.

General Electric Co., Schenectady, N. Y. Bulletin 44003 devoted to modern electric railway apparatus. The book describes briefly the Curtis steam turbine for railway service, railway generator, transformers, switchboards, synchronous converters, motor-generator sets, G-E ventilated railway motors and electric locomotives. It also contains illustrations of the G-E locomotives in use at the locks of the Panama Canal.

Poole Engineering & Machine Co., Baltimore, Md. Leaflet descriptive of the gun iron castings made by this company, which consists of charcoal gun iron mixtures of cast iron for which a tensile strength of 30,000 pounds per square inch in the castings is claimed. It is said that gears made from this material compare favorably with those made from steel, and have no tendency to "flow" under heavy loads.

Beaudry & Co., Inc., Boston, Mass. Leaflet on the Beaudry hammer, a power hammer built in two types; the "Champion" for light and heavy railroad, machine and general forging, and the "Peerless," for plaiting, drawing, swaging, collaring, spindle making and general manufacturing. The "Champion" power hammer is built in sizes from 50 to 500 pounds weight of ram and the "Peerless" hammer is built in sizes from 25 to 200 pounds weight of ram.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Catalogue 3002-A entitled "Westinghouse Electric Motors for Machine Tool Service," showing the application of electric drive to all classes of machine tools. The features of both direct- and alternating-current motors are described and hints on the selection of motors for machine tool service are given. There are also included a number of tables showing the relation between feeds, cutting speeds, diameters of work, etc.; the relation between area of cut in square inches and cutting speed in feet per minute; also horsepower required for various machines.

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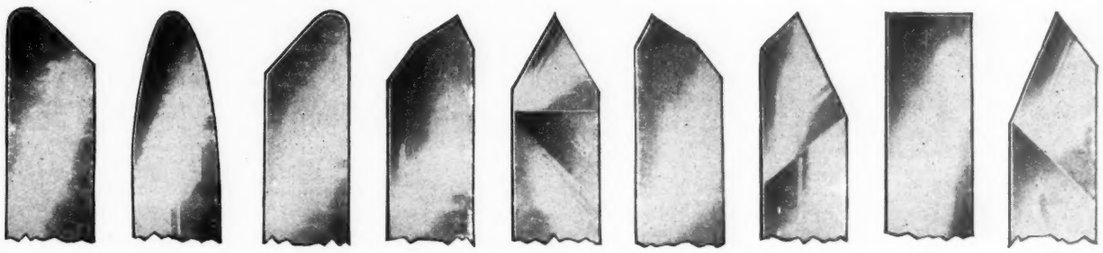
One Armstrong Tool Holder with a few cutters which can be quickly and cheaply made from the bar by any machinist will do almost any job on the lathe or shaper; roughing, facing, finishing, corner and fillet work.



1 Left-Hand Turning Tool | 2 Round-Nose Turning Tool | 3 Right-Hand Turning Tool | 4 Left-Hand Corner Tool | 5 Threading Tool | 6 Right-Hand Corner Tool | 7 Left-Hand Side Tool | 8 Square-Nose Tool | 9 Right-Hand Side Tool

40 Ounces of Armstrong Tools

The set of nine high-speed cutters shown above weighs (½" square) 40 ounces and will do a wide range of work when used in our No. 4 Tool Holder with ⅞" x 1¾" shank.

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A set of nine high-speed Forged Tools ⅞" x 1¾" will weigh 45 pounds and each additional tool added to the set adds 5 pounds, while extra cutters for Tool Holder weigh but 4½ ounces each. This shows an extra

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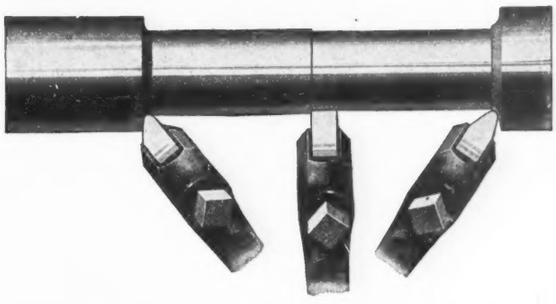

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OTHER TOOLS WE MAKE—Ratchet Drills, C Clamps, Drilling Vises, Lathe Dogs, Wrenches, Drill Drifts, Lathe Tool Posts, Planer Jacks, Drilling Posts, etc.

Boston Gear Works, Norfolk Downs, Mass. Booklet entitled "A Few Points regarding Our Gear Steels." This little book describes the two classes of special gear steel made by the Boston Gear Works and gives the physical properties of each. One grade is a low carbon steel for casehardening, and the other is a higher carbon steel for oil-tempering. Some interesting illustrations of tests made on these two grades of steel are included. The specimens shown were not specially prepared, but were selected from regular work, and show remarkable durability.

Max Ams Machine Co., Mount Vernon, N. Y. Catalogue 14 of power presses and special machinery for working sheet metals, comprising single-action inclinable presses of various sizes and capacities, double-action inclinable presses, horning and wiring presses, punch presses, open-back presses, arch presses, straight sided presses, reducing presses, double-crank presses, knuckle-joint presses, notching presses, perforating presses, dial feeds, gravity feeds, finger feeds, slide feeds, safety attachments, gang slitters, can-making machines, double seamers, etc.

Builders Iron Foundry, Providence, R. I. Bulletin 84 of cold water "Venturi" water meters for gravity mains, filtration plants, pump discharge lines, sewage disposal systems, hydraulic turbines, refrigerating plants, etc. The "Venturi" meter consists essentially of two conical tubes joined at their small ends, thus forming a contraction near the middle. This arrangement forms a part of the regular pipe system and presents practically no resistance to flow nor does it offer obstructions to catch floating matter, sediment, etc. It can be used for the largest as well as the smallest flows.

Carpenter Steel Co., Reading, Pa. Catalogue "D" of hot-rolled, hammered, cold-rolled and cold-drawn high-grade steels and wire; and rough, rough-machined, finish-machined, and heat-treated forgings. The catalogue is of unusual attractiveness and value to all having to do with steel and its treatment. Instructions for the heat-treatment of various brands of Carpenter steel are given; a chart of heat colors naming the various heats and their temperatures in centrigrade and fahrenheit scales is a valuable feature of the catalogue. Another feature that will be appreciated by users is the provision of blank pages for memoranda.

Quigley Furnace & Foundry Co., 105 W. 40th St., New York City. Bulletin 6 treating of over-fired accurate temperature heat-treating furnaces using gas or oil fuel. It is claimed that in the Quigley furnaces a soft uniform heat under the absolute control of the operator is secured at all times and that the furnace can easily be regulated so that the material cannot be overheated. The several advantages that these furnaces offer are treated in detail, and the illustrations show installations of single furnaces and batteries. The Quigley Furnace & Foundry Co. is now manufacturing the line of furnaces and equipment formerly built by the Rockwell Engineering Co. and the Rockwell Furnace Co., and is in a position to furnish promptly repair parts, burners, etc., for furnaces that have been built by these companies.

Brown & Sharpe Mfg. Co., Providence, R. I. General catalogue on screw machines, attachments and tools. In addition to listing the line of screw machines made by this company, the book contains detailed descriptions of the machines and their method of operation, being more in the nature of a treatise than a stereotyped catalogue. The various sections take up wire feed screw machines with automatic feed; plain screw machines and wire feed screw machines with roller feed; automatic screw machines; automatic screw machines with constant speed drive; automatic turret forming machines, and automatic cutting-off machines. The matter pertaining to the arrangement of oil pump and piping, friction countershaft and overhead works which follows applies to all the types of machines described. The last part of the book is devoted to attachments and tools. The logical arrangement throughout deserves special commendation. Each section gives first general information concerning the field covered by the particular machines in question, then details of important parts and their operation, and finally a general summary of the features. Following this descriptive matter, the various sizes of machines are illustrated and specifications concerning capacity, equipment, etc., of each are given. This arrangement is followed in each section. The catalogue is well illustrated and should prove of value to all interested in automatic screw machine work.

TRADE NOTES

Diamond Chain & Mfg. Co., 240 W. Georgia St., Indianapolis, Ind., has issued an announcement that it is now ready to furnish "Diamond" roller chains of the cotter-pin detachable type in all sizes above ¾ inch pitch.

Abbott Ball Co., Elmwood, Hartford, Conn., announces that it has perfected special machinery for the manufacture of bearing balls. It is now prepared to turn out the highest grade balls in all sizes from ⅛ inch to ½ inch diameter and later will be prepared to furnish other sizes.

W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill., manufacturer of lathes, drilling machines and wood-working machinery, has appointed the Charles A. Strelinger Co., exclusive sales agents for the sale of Barnes drills in the Detroit territory, the arrangement having gone into effect November 18.

Chamberlin Co., Detroit, Mich., has changed its location from 409-410 Free Press Bldg. to 1201-1203 Kresge Bldg. This company has made a specialty of selling and advertising campaigns for manufacturers of machinery, power plant equipment, etc., for a number of years past. C. W. Brooke has acquired an interest, and has been made secretary and treasurer. William M. Chamberlin is the head of the company.

Standard Mfg. Co., Bridgeport, Conn., has purchased the patterns, tools, rights and good will of the Flint Mfg. Co., Boston, Mass., and will carry on the manufacture of the cutter grinders formerly manufactured by the Flint Mfg. Co. The Standard Mfg. Co. has taken over all parts, both finished and unfinished, and is now prepared to furnish this machine, which will be known in the future as the "Standard" combination cutter and tool-room grinder.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa., has issued an announcement that the United States Circuit Court of Appeals handed down a decision October 7, sustaining the basic Conrad patent belonging to the company. The litigation involved only one patent, namely, that covering the article and not the one relating to a method. The uninterrupted ball track or way and the overhang of the groove sides form the essence of the patent and were so defined by the U. S. Court.

Lutz-Webster Engineering Co., Inc., Philadelphia, Pa., is offering eighteen cash prizes from $100 to $5 for: (1) the most interesting account of universal use of Lutz tools; (2) best application of Lutz tools under difficult or unusual conditions; (3) origination of new uses or ideas having a commercial value. The contest closes August 1, 1915. Bulletin 4 outlines the uses of the Lutz line which comprises compression wrenches, drill posts, compression ratchets, double-end sockets, lathe dogs, drill sockets, bridge and extension sockets.

Alexander Hamilton Institute, Astor Place, New York City, has recently published the results of investigations made by its research department concerning the effects of the war on American business. This report takes the form of a world map on which are indicated the trade opportunities opened to Americans through the partial suspension of the commerce of the countries at war. It is of interest to note that machinery and iron and steel goods are listed among the imports of almost every country. The tabular statement of American industries printed on the back of the map gives the principal industries of America, the number of people engaged in them, capital employed, annual production, exports and imports, effects on foreign trade, effects on prices, and other effects.

Classified Advertisements—Situations, Help Wanted, For Sale, etc.

Advertisements in this column, 20 cents a line, seven words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

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